

Zürcher Hochschule für Angewandte Wissenschaften ZHAW

School of Management and Law

Institute for Financial Management

Master of Science in Banking & Finance

Master's Thesis

“The impact of ESG scores on a firm's cost of capital”

Submitted by:

Marius Löffler

Supervised by:

Prof. Dr. Robert Gutsche

Institute for Financial Management

Dr. Orcun Kaya

Institute for Financial Management

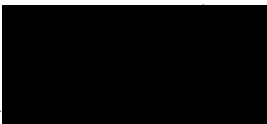
Winterthur, June 15th, 2023

Statement of authorship

I hereby declare that this thesis is my own work, that it has been created by me without the help of others, using only the sources referenced, and that I will not supply any copies of this thesis to any third parties without written permission by the head of this degree program.

At the same time, all rights to this thesis are hereby assigned to ZHAW Zurich University of Applied Sciences, except for the right to be identified as its author.

Marius Löffler

—  —

Management summary

This master's thesis investigates the impact of ESG scores on a firm's cost of capital by answering the research question "To what extent do ESG scores influence a firm's cost of capital?". Thereby, a negative character of the relationship between ESG scores and a company's cost of capital is assumed while the conclusions of this thesis shall supplement the state of research to the extent that it investigates the impact of a company's ESG score on the effect chain from a company's risk profile to its cost of equity, cost of debt, and the weighted average cost of capital comprehensively to gain a full picture of the impact.

To arrive at the conclusions, the study utilizes fixed effect regression analyses with four different models that carry the beta factor, the cost of equity, the cost of debt, and the weighted average cost of capital as the dependent variables respectively. At the same time, the ESG score serves as the independent variable of interest and it is controlled for firm characteristics by incorporating the natural logarithm of total assets, the leverage ratio, the return on assets, and the price-to-book ratio as control variables. Furthermore, the produced results are validated by performing three distinct robustness tests. Eventually, a balanced panel dataset comprising 1625 observations from 355 unique stocks listed in the S&P 500 over the period from 2017 to 2021 serves as the basis for the present empirical investigation.

The results suggest rejecting the first hypothesis that good ESG scores lead to lower beta factors. Thus, no evidence for the assumed risk-mitigating impact of ESG scores as a trigger for an effect chain that leads to lower capital costs for a firm is provided. However, the three further hypotheses are confirmed with the regression results demonstrating a significant negative relationship between the ESG score and the cost of equity, the cost of debt, and the weighted average cost of capital.

Consequently, this research provides backing for the significant negative relationships between ESG scores and the three dimensions of a firm's cost of capital that have been observed in previous studies. Furthermore, the findings imply that firms with good ESG scores benefit from lower cost of capital which introduces an economic argument to managerial considerations regarding ESG performance enhancements. Besides, they support the effectiveness of ESG-related regulations and directives that force firms to

Management summary

face the tradeoff between their ESG performance and their cost of capital and provide valuable insights for finance professionals in the field of security valuation where the costs of capital are of central importance.

Table of contents

Statement of authorship	I
Management summary	II
Table of contents	IV
List of figures	VII
List of tables	VIII
List of abbreviations	IX
1 Introduction	1
1.1 Relevancy and status quo	1
1.2 Research question and goal	2
1.3 Structure and methodology	3
2 Literature review	5
2.1 Definition and history of ESG scores	5
2.1.1 Definition of ESG scores	5
2.1.2 ESG score providers and credibility issues	7
2.2 Company-specific and systematic risk	10
2.2.1 Definition of company-specific and systematic risk	10
2.2.2 ESG performance and company-specific risk	10
2.2.3 ESG performance, systematic risk, and beta factors	11
2.3 ESG, risk, and return	12
2.3.1 The risk-return relationship	12
2.3.2 ESG scores' role in the risk-return relationship	12
2.4 ESG scores and cost of equity capital	14
2.4.1 Definition and composition of the cost of preferred stock	14
2.4.2 Definition and composition of the cost of common equity	15
2.4.3 Empirical studies about ESG scores and cost of equity capital	16
2.5 ESG and cost of debt capital	18
2.5.1 Definition and composition of cost of debt capital	18
2.5.2 Empirical studies about ESG scores and the cost of debt capital	20

Table of contents

2.6	ESG and the weighted average cost of capital	22
2.6.1	Definition and composition of the weighted average cost of capital	22
2.6.2	Importance of the weighted average cost of capital	23
2.6.3	Empirical studies investigating ESG scores' relationship with the WACC	24
3	Research framework and hypotheses	27
3.1	Research framework	27
3.2	Hypotheses	27
4	Data and research methodology	30
4.1	Panel data sample	30
4.2	Dependent variables	33
4.2.1	The beta factor	33
4.2.2	The cost of equity	33
4.2.3	The cost of debt	33
4.2.4	The weighted average cost of capital	34
4.3	The ESG Score as the interest variable	34
4.4	Control variables	36
4.4.1	Ln total assets	36
4.4.2	Leverage ratio	36
4.4.3	Return on assets	37
4.4.4	Price-to-book value	38
4.5	Regression models	40
4.6	Model specifications	42
4.6.1	OLS regressions and the distribution of residual errors	42
4.6.2	White test to check for homoscedasticity in the residual errors	43
4.6.3	Durbin-Watson test to check for autocorrelation in the residual errors	44
4.6.4	Hausman test to decide on fixed effect or random effect regression analyses	45
4.7	Robustness test designs	46
4.7.1	Excluding the year 2020	46

Table of contents

4.7.2	Excluding ESG Score as an independent variable.....	46
4.7.3	Replacing ESG Score with a dummy variable	46
5	Empirical results.....	47
5.1	Descriptive statistics	47
5.2	Pearson correlation matrix.....	49
5.3	Results for Model 1 investigating the ESG score's impact on beta	51
5.4	Results for Model 2 investigating the ESG score's impact on the cost of equity	52
5.5	Results for Model 3 investigating the ESG score's impact on the cost of debt	53
5.6	Results for Model 4 investigating the ESG score's impact on the WACC	54
6	Discussion	55
6.1	ESG scores do not significantly impact beta	55
6.2	ESG scores have a significant negative relationship with the cost of equity .	56
6.3	ESG scores have a significant negative relationship with the cost of debt	57
6.4	ESG scores have a significant negative relationship with the WACC	57
6.5	ESG scores remain significant when sqrt. transforming Leverage	58
6.6	ESG scores remain significant when omitting the large volatility in 2020	59
7	Conclusion	60
	Bibliography.....	IX
	Appendix	XV

List of figures

Figure 1: Composition of the Refinitiv ESG Score.....	6
Figure 2: Investor rating of the average quality and usefulness of ESG Scores	9
Figure 3: The research framework.....	27
Figure 4: Distribution of GICS sectors across the balanced panel data set (absolute figures).....	32
Figure 5: Distribution of years for all 1625 observations.....	32
Figure 6: The expected influence of the control variables on the dependent variables..	39
Figure 7: QQ plots of the residual errors from the OLS regression results.....	42
Figure 8: Pearson correlation heatmap matrix of the variables used.....	49

List of tables

Table 1: ESG score range and description.....	35
Table 2: Omnibus and Jarque-Bera test results for the residual errors of the OLS regressions	43
Table 3: White test results for the residual errors of the OLS regressions.....	43
Table 4: Durbin-Watson test statistic results and critical value range	44
Table 5: Hausman test results for the four regression models.....	45
Table 6: Descriptive statistics of the used variables.....	47
Table 7: Fixed effect regression result for Model 1 including robustness tests	51
Table 8: Fixed effect regression result for Model 2 including robustness tests	52
Table 9: Fixed effect regression result for Model 3 including robustness tests	53
Table 10: Fixed effect regression result for Model 4 including robustness tests	54

List of abbreviations

CoD	Cost of debt
CoE	Cost of equity
CSR	Corporate Social Responsibility
ESG	Environmental, Social, and Governance
GICS	Global Industry Classification Standard
H1	Hypothesis one
H2	Hypothesis two
H3	Hypothesis three
H4	Hypothesis four
KLD	Kinder, Lydenberg, Domini & Co., Inc.
Ln	Natural logarithm
NGO	Non-profit organization
PB-ratio	Price-to-book ratio
ROA	Return on assets
Sqrt.	Square root
WACC	Weighted average cost of capital

1 Introduction

This chapter deals with the status quo of the research on companies' ESG ratings and their impact on the firm's cost of capital. It introduces the reader to the research question and goal and displays the used methodology as well as the structure of the paper.

1.1 Relevancy and status quo

ESG scores have become a highly relevant topic for capital markets and political agendas such as the current discussions in the U.S. Congress as the Republican-controlled House of Representatives passed a bill intending to prevent pension fund managers from investing based on ESG-related decision factors (Morgan, 2023). The rationale for that bill lies within their view of ESG-based investing's harmful impact on pension funds' financial performance. Pastor et al., (2020) provide backing for this view, finding a lower risk-adjusted expected return in the long-term equilibrium for investments in companies with higher ESG scores. Moreover, several empirical studies on the impact of ESG-related risk on asset prices have shown that highly carbon-emitting companies exhibit greater tail and variance risk (Ilhan et al., 2021), that investors seek higher returns for exposure to carbon risk (Bolton & Kacperczyk, 2019), and that good ESG performance reduces an assets downside risk (Hoepner et al., 2016). Consequently, companies with higher ESG scores seem to carry less risk and at the same time yield lower expected returns in the long-term equilibrium. Simultaneously, they have been found to face lower costs of capital in the form of equity as well as debt capital which traces back to investors' higher return expectations for equity and debt capital invested in companies linked to ESG-related concerns and thus exhibiting greater risk (Chava, 2011).

Regarding a firm's cost of debt, it has been found that ESG factors have a negative impact on company bond yields in the primary market where the issuance price is determined through discussions between the issuer and the underwriter. The latter seems to be more sensitive to ESG-related affairs than stakeholders in the secondary market thus accounting for the risk associated with ESG which reflects in the primary market bond yields. Contrarily, investors in the secondary market do not seem to incorporate ESG risks as systematically as primary market investors leading to inconclusive findings on ESG scores' negative impact on a firm's cost of debt (Apergis et al., 2022). Furthermore, the effect of ESG disclosures being used as a communication tool on companies' cost of debt

Introduction

has been investigated. The respective literature suggests that managers should expand their ESG disclosure activities across various channels and make the relevant data effortlessly available to potential lenders as a negative relationship between ESG disclosure and the cost of debt has been found (Raimo et al., 2021).

On the other hand, the reviewed literature suggests a similar relationship between ESG scores and

a company's cost of equity capital. The empirical investigation of ESG scores' impact on the cost of equity of firms operating in the oil and gas sector found increasing ESG scores to cause declining costs of equity with the relationship following a U-shape as they rise again after the firms' total assets exceeded a size threshold (Bellavite Pellegrini et al., 2019). Other research using sample data from more than 3000 firms concludes akin observations that a negative relationship between companies' ESG performance and their cost of equity exists (Ng & Rezaee, 2015). These findings are constant with previous studies finding that CSR performance, which is perceived as the precursor of ESG performance, mitigates the information asymmetry between management and shareholders on non-financial performance and thus has a significant negative impact on companies' cost of equity capital (El Ghoul et al., 2011).

1.2 Research question and goal

The reviewed research on the relationship between ESG scores and the cost of capital respectively cost of debt, cost of equity, and the weighted average cost of capital primarily investigates only one of the mentioned dimensions. Therefore, this research ought to shed light on the effect ESG scores have on a firm's cost of debt, cost of equity, as well as the weighted average cost of capital across a large data set of publicly traded companies which is a research topic Raimo et al., (2021) suggest.

Consequently, this thesis aims to answer the research question "To what extent do ESG scores influence a firm's cost of capital?" whereby it focuses on the nature of the relationship between ESG scores and a company's cost of capital with the core assumption of a negative character. Higher ESG scores should be associated with a lower risk level and cost of capital for the firms. Thereby, the findings intend to get in line with existing empirical research finding negative relationships between ESG scores and cost

Introduction

of equity respectively cost of debt individually. Furthermore, the conclusions of this thesis shall supplement the state of research to the extent that the impact of a company's ESG score on the effect chain from company risk to its cost of equity, cost of debt, and the weighted average cost of capital is investigated comprehensively for each firm in the sample dataset to gain a full picture of the impact.

Nevertheless, the author considers ESG scores holistically and does not investigate the individual constituent's (environment, social, and governance) influence. Furthermore, a separate investigation of the used ESG scores would go beyond the scope of this thesis which is why a good score is defined according to the score provider's frameworks. Lastly, the research does not specifically consider the panel data companies' business activities and industries but takes a holistic view based on the US-based companies listed in the S&P 500 over the period from 2017 to 2021.

1.3 Structure and methodology

A compulsory literature review is the basis on which the research question of this thesis is answered. The findings of this review are compiled in chapter two and intend to display the origination, importance, and role of ESG scores for companies and capital markets, the implications they have for company risk, and the risk-return relationship. Moreover, it continues defining the cost of equity, the cost of debt, and the weighted average cost of capital followed by a breakdown of their composition and drivers before concluding their interpretation and importance. Hereby, the latter shall describe the levers through which ESG factors can potentially influence a company's cost of capital across the three mentioned dimensions as this is the focus of this research.

The thesis continues by elucidating the research framework and the subsequent hypotheses derived from it before describing the methodology and data. Thereby, fixed effect regression analyses with the relevant variables concluded from the four central hypotheses of this study serve as the methodological foundation. The variables are the ESG score as the interest variable and beta, cost of equity, cost of debt, and weighted average cost of capital as dependent variables while the natural logarithm of total assets, leverage ratio, return on assets, and the PB-ratio depict the control variables. Besides, the

Introduction

data used is retrieved from Refinitiv and further explained together with a more granular illustration of the methodology in the devoted chapter four.

Hereafter, the results of the regression analyses are presented in chapter five and discussed in chapter six before a compulsory conclusion of the research's main findings as well as limitations and ideas for further investigation are suggested in the final chapter of this thesis.

2 Literature review

This chapter gives an overview of the literature that has been reviewed for this master's thesis and serves as the underlying basis for the research design.

2.1 Definition and history of ESG scores

As solicited in the introduction of this thesis, environmental, social, and governance (ESG) scores have gained increasing attention among regulators, politicians, company executives, professional investors, and retail investors. This trend lies within and is further pushed through sustainable finance initiatives such as the Non-Financial Reporting Directive (NFRD) and the Corporate Sustainability Reporting Directive (CSRD) on firm's disclosure requirements regarding environmental and social matters as well as through comparable governance-related directives (La Torre et al., 2023, p. 62). Furthermore, the attention has become so central, that they developed into an important criterion in the investment decision-making process (PricewaterhouseCoopers, n.d.). Consequently, it is of interest for this research how ESG scores are defined and how respectively by whom they are provided.

2.1.1 Definition of ESG scores

Similarly, to no uniform regulation on ESG scores, an official definition of ESG scores and ratings has not been established, which is why the European Securities and Markets Authority (ESMA) suggested a broad definition in a letter to the European Commission. Therein ESMA (2021) presents the following definition:

“ESG rating means an opinion regarding an entity, issuer, or debt security's impact on or exposure to ESG factors, alignment with international climatic agreements or sustainability characteristics, issued using a defined ranking system of rating categories”.

Under the realm of this broad understanding of ESG scores, they are the result of the combination of company ratings across the main categories of environmental issues, social issues, and governance issues. More granularly, sources for environmental issues can arise from the environmental impact, resource consumption, waste management, or

Literature review

from potentially harmful effects on biodiversity through a company's business activities. Social issues can stem from a company's impact on communities and suppliers or the working conditions within the organization. Moreover, the root of governance issues can lie within a company's transparency, its board structure, constitution, and function, or the compensation policy (Ribando & Bonne, 2010). Hereby, the stated examples of potential sources of environmental, social, or governmental issues are not exhaustive but shall display the kind of data points that are collected to establish the category scores respectively ratings that combined represent a holistic ESG score.

The following illustration (Figure 1) based on the framework used by Refinitiv, one of the largest ESG score providers covering more than 12,500 public and private companies, displays the exemplary composition of an ESG score from data point collection for ESG metric creation to aggregating them into ESG measures and finally feeding them into scores for the three categories respectively into an overall ESG score.

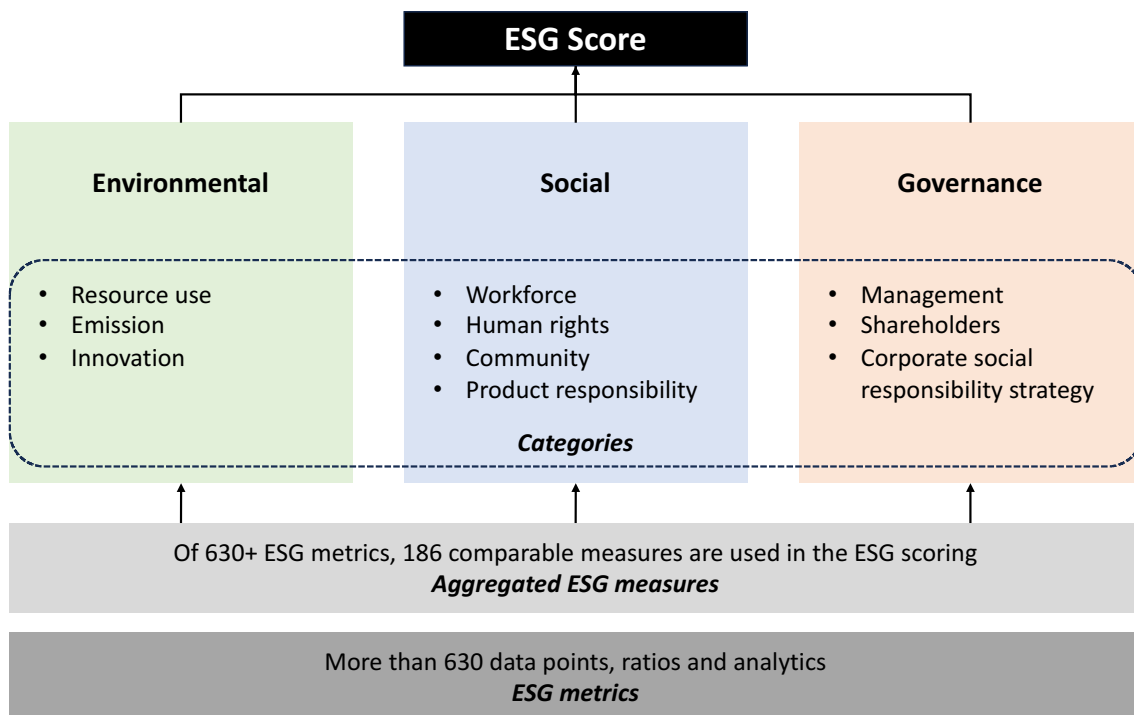


Figure 1: Composition of the Refinitiv ESG Score (Refinitiv, 2022)

A study intending to gather all definitions of ESG scores used in academic literature concludes that in finance, ESG scores are mostly used to assess companies on ESG issues or to analyze the risk of negative impacts on companies posing from ESG events in the future. Consequently, ESG scores in finance serve as a variable to analyze the risks associated with them and were established to serve investors' needs when conducting such analysis (Clément et al., 2023).

Eventually, as there is no universal definition for ESG scores, their understanding in this research shall be aligned with ESMA's broad definition and how ESG scores have been recognized in the finance literature until this day. Therefore, ESG scores within the scope of this thesis are defined as the output of a ranking system for the three rating categories environment, social, and governance which serves investors to assess companies on and analyze the risk stemming from ESG-related concerns.

2.1.2 ESG score providers and credibility issues

First studies investigating the role and influence of environmental, social, and governance criteria in and on a firm's financial performance date back to the early 1970s and display the foundation of sustainability concerns becoming an issue to be considered in the capital markets (Friede et al., 2015). Since then, a multitude of organizations that collect and analyze relevant data as well as rate and rank consequent company ESG performances have been established. Thereby, the universe of these organizations is very diverse to the extent that some are for profit while others are non-profit or that they focus on a subject such as carbon emissions whereas others focus on all ESG-related reporting matters. This can be observed although large organizations with reputable names such as Thomson Reuters, Bloomberg, MSCI, or ISS, have consolidated the market since 2009 through several acquisitions of smaller players. This consolidation trend is further fueled by increasing demand for ESG data and score providers to cover a global universe of companies at a significant scale to satisfy the data user's needs for a large amount of data as the basis for their analyses (Eccles & Strohle, 2018).

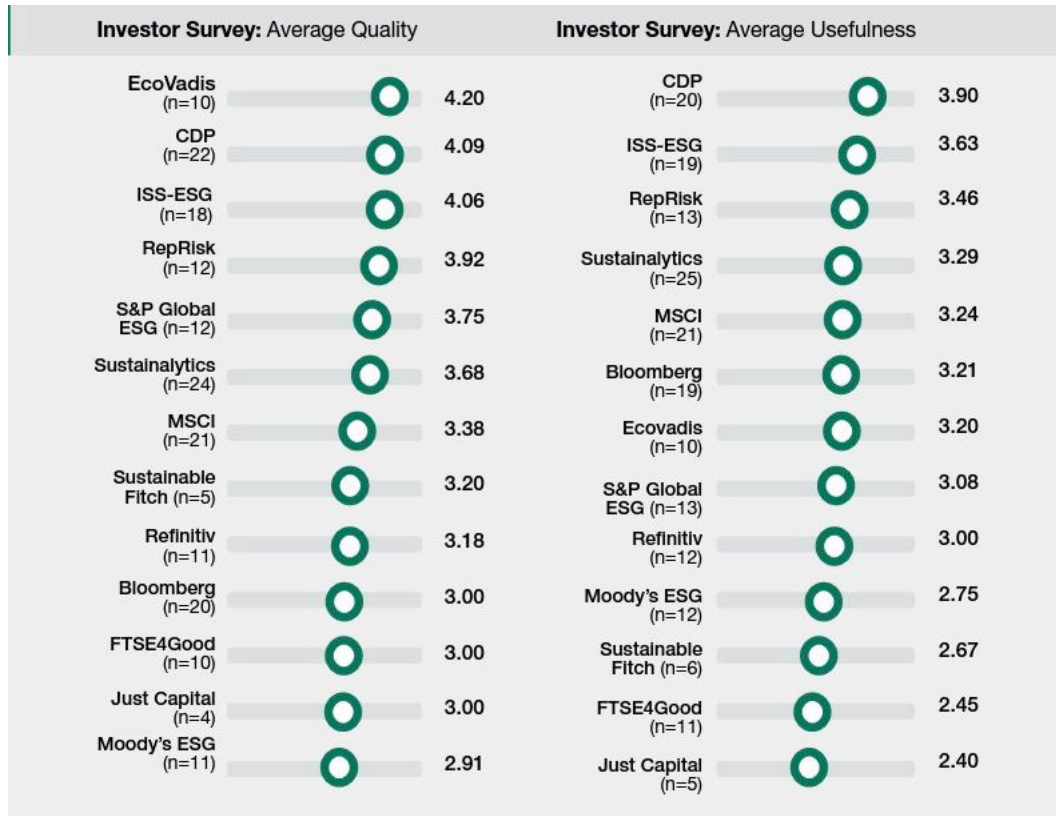
ESG score providers usually collect the relevant ESG data needed to establish their scores periodically e.g., annually through surveying the companies within their coverage, analyzing their (sustainability) reports, and interviewing employees in relevant positions

or other stakeholders in the firms. Additionally, some providers use technology such as artificial intelligence and natural language processing to extract raw data from the internet. Eventually, all ESG score providers have proprietary methodologies to transform the gathered data into an ESG score as their goal is to sell these scores with a unique and distinct value proposition. While this might be essential for their business, it creates an opaqueness leading to score users having credibility doubts regarding the validity of the scores (Eccles & Strohle, 2018).

For that reason, The SustainAbility Institute by ERM introduced the “Rate the Raters” report over a decade ago which is published annually and grasps the sentiment towards ESG rating providers among investors, companies, and other stakeholders using it. Their recently published report displays the growing importance of ESG scores with regulators globally introducing disclosure rules. Consequently, 43% of the surveyed investors claimed they are required by their employer to integrate ESG scores and data into investment strategies in 2022 compared to only 12% in 2018/2019. Additionally, 47% use ESG scores multiple times per week (vs. 35% in 2018/2019) and 94% use them at least once a month (vs. 78% in 2018/2019). At the same time, 52% of corporate and 59% of investor respondents answered with only moderate trust in ESG scores precisely reflecting a company’s ESG performance. Meanwhile, 29% of corporates indicated low to very low trust in the scores conveying an accurate picture of the ESG performance (Brock et al., 2023).

Literature review

Nevertheless, investors seem to favor the large players such as Evocvadis, CDP, ISS-ESG, or RepRisk according to the investor rating of their average quality and usefulness as displayed in Figure 2.



Respondents were asked to rate each ESG rating provider on a scale of 1-5 for both quality and usefulness. The above chart shows the ESG raters receiving the highest average scores in quality and usefulness among investor respondents. n only includes those who scored 1-5.

Figure 2: Investor rating of the average quality and usefulness of ESG Scores (Brock et al., 2023)

2.2 Company-specific and systematic risk

As described in 2.1, ESG scores are often used in the academic finance literature to assess companies on and analyze the risk stemming from ESG-related matters. Therefore, this subchapter intends to shine a light on the systematic and company-specific risk in general but also how it is influenced by a company's ESG performance.

2.2.1 Definition of company-specific and systematic risk

In academic finance, the risk associated with the stock of a company is split between company-specific risk (also known as unsystematic, idiosyncratic, or simply specific risk) and systematic risk. Both risk measures are central to the portfolio theory and the capital asset pricing model of Harry M. Markowitz and William F. Sharpe. Hereby, their work suggests that the company-specific risk stemming from factors such as business risk, financial risk, or liquidity risk is inherent to the individual stock of a company and unique to the company's features. Consequently, it can be eliminated through diversification which makes this measure of risk obsolete within the portfolio and capital asset pricing theory. Contrarily, the systematic risk depicting the co-movement of the individual company stock with the market portfolio is considered highly relevant. Furthermore, it is considered to describe the extent to which the company stock's total variance can be traced back to the variability of the market and is referred to as the stock's beta factor (Reilly & Brown, 2012, p. 20).

2.2.2 ESG performance and company-specific risk

As stated above, under the assumptions of the portfolio theory and the capital asset pricing model, company-specific risk can be diversified away making it needless for companies to invest in risk management to reduce company-specific risk (Godfrey et al., 2009, p. 427). Nonetheless, empirical studies show that under imperfect real-world market conditions, adequate risk management measures intended to limit a company's exposure to specific risks can reduce the risk of costs associated with specific risk events to an extent that cannot be reached through diversification (Smith & Stulz, 1985).

Hence, company-specific risks are meaningful to companies as well as investors, and the measures to mitigate them are as versatile as their causes. Nevertheless, as this thesis investigates the impact of ESG scores on a firm's cost of capital, those risk management

measures addressing company-specific risk related to ESG events are of interest. Hereof, it is empirically observed that companies that perform well in ESG matters reduce the likelihood of running into ESG issues with negative consequences for their financial performance (Sharfman & Fernando, 2008). That is due to the distinct risk management practices and compliance standards found in such companies. Additionally, a good ESG performance is observed to limit downside risks (Hoepner et al., 2016) and to function as insurance-like protection in the event of negative ESG events (Jo & Na, 2012).

Consequently, the reviewed literature asserts that high ESG scores as the result of good ESG performance and practices in firms can mitigate and thus beneficially influence a company's risk profile.

2.2.3 ESG performance, systematic risk, and beta factors

Beta as the measure of a company's stock systematic risk not only plays a central role in the portfolio theory and the capital asset pricing model but also in the calculation of a firm's cost of capital. This is because beta is used to calculate the equity risk premium and thereby the return investors require from a company which is a fundamental driver of the company's cost of capital (Ruefli et al., 1999).

Besides, literature investigating the relationship between ESG-related performances and the firm value asserts that ESG well-performing companies face less exposure to systematic risk displayed by lower beta factors compared to firms associated with ESG concerns (Gregory et al., 2014). Furthermore, Giese et al. (2019) observe companies within the MSCI World Index scoring high in ESG to demonstrate lower systematic volatility and lower beta levels than low-scoring peers over a 10-year period from 2007 to 2017.

In conclusion of this sub-chapter, it can be said that similar to the dimension of company-specific risk, finance professionals researching the implications of ESG performance for a company's systematic risk find a good performance to be favorable to the firm.

2.3 ESG, risk, and return

The literature discussed in the two preceding sub-chapters on the impact that a company's ESG performance has on the unsystematic and systematic risk both assert a negative relationship meaning a good ESG performance mitigates the risk associated with the company. Hereby, risk depicts one component of the risk-return relationship which's tangency with ESG scores is discussed in this chapter.

2.3.1 The risk-return relationship

The risk and return relationship is one of the most investigated topics in academic finance and is of utmost importance for the stock market. The in chapter 2.2 referenced portfolio theory from Markowitz is one of the first studies to investigate this relationship. Thereby, he alludes that an asset portfolio balance delivering a maximum return rate can be computed for any risk level acceptable by the portfolio holder (Markowitz, 1952). The model's foundational idea of the risk-return relationship has been further developed by Sharpe and Lintner and culminated in the emergence of the capital asset pricing model, the most prominent work to examine the risk-expected return relationship (Bodie et al., 2008).

All things considered, a variety of empirical studies on the risk-return relationship have been researching the nature of the relationship with the predominant hypothesis of a positive relationship leading to an increase in expected return as a consequence of an uptick in systematic risk. The findings of the studies are inconsistent. While some studies find the risk-return relationship to be empirically weak (He & Ng, 1994; Miles & Timmermann, 1996), conclude others that there is no significant relationship (Davis, 1994). Nevertheless, for several decades an array of researchers investigating different stock markets such as the Security Exchange of Thailand (Sareewiwatthana & Malone, 1985), the UK stock market (Fletcher, 1997), and the international stock market (Fletcher, 2000) find the relationship between systematic risk and return to be significant and positive.

2.3.2 ESG scores' role in the risk-return relationship

Chapter 2.2 presents an overview of literature describing how companies' ESG performance and consequently ESG scores influence the specific as well as systematic

risk associated with the company. Moreover, 2.3.1 deals with the (systematic) risk-return relationship per se and alludes to a positive relationship. Consequently, the question arises about which role ESG scores play in that relationship as firms performing well in terms of ESG scores tend to be perceived as less risky.

Pastor et al. (2020) find green assets, defined as assets with good ESG characteristics, to yield lower expected returns (than brown assets which are defined inversely) in the equilibrium due to their profile as a hedge against climate risk. At the same time, they can provide outperformance if ESG events shift customer demand and investor appetite beneficial to firms representing green assets.

Furthermore, empirical evidence for a carbon emission premium is delivered. Carbon emission is only a driver for one pillar of the overall ESG performance, the environmental pillar, of a firm but seems to be significant as investors appear to price in carbon risk and thus expect a higher return on the emitting company's stock (Bolton & Kacperczyk, 2019). To arrive at these findings, Bolton & Kacperczyk (2019) ran regression analyses on a data sample of US-listed stocks over the period from 2005 to 2017. Thereby, the sample consisted of 3421 companies' scope one, two, and three greenhouse gas emission data as well as their stock returns, institutional ownership, and corporate fundamentals. Eventually, they regressed the firm's monthly stock return against the three levels of greenhouse gas emission individually while the models controlled for firm-specific variables proven to influence returns as well as year and month fixed effects.

Moreover, research utilizing the Markovitz mean-variance framework depending on equity portfolios' ESG score of the NYSE over a two-year period from 2018 to 2019 delivers congruent findings. Optimized portfolios in the ESG top deciles are associated with lower returns and lower volatility than those in the bottom deciles whereby the returns are lower to an extent that drags their Sharpe ratios below those of bottom ESG portfolios (López Prol & Kim, 2022).

Finally, Cornell (2021) discusses investors' ESG preferences, risk and return driven by the trend of sustainable investing, and the mere sum of funds making their way into ESG-related investments. He finds that portfolio tilts toward shares of firms with high ESG scores also mean a tilt toward a portfolio with higher share prices but lower expected

returns due to the lower risk levels associated with them. Furthermore, he states that the trend of capital flowing into ESG high-performing companies is socially beneficial as the lower expected returns decrease the cost of equity capital for such which catalyzes the investment in green technologies. At the same time, the study suggests that the knock-on effect of lower expected returns and the followingly diminished cost of equity capital increases the value of companies with high ESG scores.

2.4 ESG scores and cost of equity capital

The reviewed literature asserts that there is an impact channel through which ESG scores can influence a firm's risk profile, its expected return, and consequently its cost of equity. Therefore, a company's cost of equity is elementary to this thesis and will be discussed in this chapter. Further, the chapter is closed with an overview of empirical studies about the influence ESG scores have on the cost of equity capital.

2.4.1 Definition and composition of the cost of preferred stock

Next to common shares, companies can issue preferred stock in order to raise equity capital. These stocks are entitled to preferred dividends in exchange for waiving voting rights and can additionally come with special features such as a call option, convertibility into common stock, cumulative dividends, participating dividends, or adjustable-rate dividends. These features need to be paid respect to if a company decides to issue preferred stock that is not equipped with such. In that case, the yield estimate derived from the current yield of already issued stock holding a certain set of special features needs to be adjusted. Alternatively, the yields of comparable companies' preferred stock without special features can be used to estimate the cost of preferred stock.

Nevertheless, the cost of preferred stock is the dividend paid to preferred stockholders as the return required for them to provide the equity capital. Generally, the cost of preferred stock for nonconvertible and noncallable preferred stocks paying a fixed dividend rate and without a maturity date can be computed through the following process.

Literature review

Firstly, the value of a preferred stock can be calculated using this equation:

$$P_p = \frac{D_p}{r_p}$$

where:

P_p = current share price of preferred stock

D_p = dividend per share for preferred stock

r_p = cost of preferred stock

Secondly, the calculation must be rearranged to solve for the cost of preferred stock:

$$r_p = \frac{D_p}{P_p}$$

Eventually, dividing the dividend per share for the preferred stock by the current share price of the preferred stock delivers the cost of preferred stock (Clayman et al., 2012, pp. 138–139).

2.4.2 Definition and composition of the cost of common equity

The cost of (common) equity capital generally represents the expected return shareholders demand in exchange for the risk they take by investing in a company's (common) share. Again, the often-referenced capital asset pricing model (CAPM) can be used to determine a company's cost of (common) equity capital. The model shows that the diversified market portfolio only represents the systematic risk, implying similar risk levels for investment opportunities with equal market risk sensitivities. Hence, the CAPM states the equality of an investment's expected return and its cost of equity capital which is depicted through the security market line and the following equation:

$$r_i = r_f + \beta_i \times (E[r_m] - r_f)$$

where:

r_i = required return for the investment i

r_f = risk-free interest rate

β_i = beta factor of the investment i

$E[r_m]$ = expected market return

Hereby, $\beta_i \times (E[r_m] - r_f)$ represents the risk premium investors require as it is comparable to the return they would get by taking on an equal systematic risk exposure through investing in the market portfolio (Berk & Demarzo, 2019, pp. 443–444). Essential to this calculation is the market risk premium $E[r_m] - r_f$ which is used as an estimate for the equity risk premium in the CAPM.

Nevertheless, alternatives to arrive at an estimate for the equity risk premium have been established. Since the market portfolio in the CAPM might not account for other sources of risk that investors require to be compensated for, a multifactor model incorporating these factors may be used. A further alternative depicts a historical equity risk approach which assumes that the average surplus return of a country's market portfolio over this country's risk-free rate observed over a long period of time in the past embodies an adequate gauge for the equity risk premium. Lastly, the dividend discount model and leveraging the Gordon growth model can alternatively be utilized to calculate the implied risk premium of a company's stock. Thereby, the dividend discount model can also be used as an alternative to the CAPM to determine a firm's cost of equity capital based on the firm's current stock price, its next-period dividend, and growth rate (Clayman et al., 2012, pp. 140–146).

2.4.3 Empirical studies about ESG scores and cost of equity capital

As mentioned in the introductory words to subchapter 2.4, the literature reviewed in the context of this master's thesis suggests that ESG scores can have an influence on a company's risk profile and cost of equity capital. A compulsory study based on a data sample covering more than 3000 firms over a timeframe from 1990 to 2013 investigated

Literature review

if the sustainability performance of the firms across the dimensions of environmental, social, and governance affects their cost of equity. Additionally, the effect of the economic sustainability performance individually as well as jointly with the ESG performance was investigated. Hereby, the study finds both to have a significant and negative relationship with the firm's cost of equity. However, only growth and research for the economic sustainability dimension and environmental and governance seem to contribute to that finding. Operation efficiency is found to contribute positively and social sustainability only marginally to the observed relationship. Eventually, the researchers conclude that economic and ESG sustainability interactively impact the firms' cost of equity while the negative relationship of the one dimension is stronger when the other dimension's performance is strong too (Ng & Rezaee, 2015).

Besides, (Chava, 2011) analyzed how firms' environmental externalities and the cost of capital are related using implied costs of capital derived from analyst estimates and environmental concerns that firms exhibit. His findings show an adverse repercussion of weak environmental company profiles on their cost of equity as they are significantly higher. Investors apparently take the risks stemming from e.g., carbon emission into account and seek compensation for it which reflects in a higher expected return. Nevertheless, a strong environmental profile does not lead to a lower cost of equity.

Congruent with the findings of research on the impact of ESG performance on a firm's cost of capital that have been gathered in the literature review to this point, empirical research on the effect of implementing strategic environmental risk management in a firm suggests lower costs of equity. Furthermore, the work referred to outlines that this reward from the financial markets is mainly obtained through a consequent reduction of the implementing firm's stock volatility expressed by the measure of systematic risk, beta. Additionally, the paper alludes to a minor contribution to lowering the cost of capital through environmental risk management lying within the higher demand for shares of environmentally well-performing firms (Sharfman & Fernando, 2008).

Another aspect related to the field of ESG whose influence on a firm's cost of equity capital has been empirically investigated is the reporting and disclosure activity. Superior CSR performance compared to industry counterparts leads to a reduction in the cost of equity capital after the voluntary disclosure through a dedicated report. Additionally, the

capital markets welcome such activities shown by an attraction of institutional investors and analyst coverage. Consequently, the disclosure represents a potential strategic tool for company executives (Dhaliwal et al., 2011).

Eventually, this overview of empirical studies asserts a negative relationship between ESG performance and a firm's cost of equity capital which is in line with the assertion derived from the reviewed work on the ESG score's influence on the risk-return relationship.

2.5 ESG and cost of debt capital

A central issue in corporate finance is the management of a firm's capital structure. That is because firms rely on two different funding sources, namely equity and debt capital, to finance their operations and projects. Consequently, to investigate the influence of ESG scores on a firm's cost of capital, the costs of debt capital need to be considered too which is the focus of this chapter.

2.5.1 Definition and composition of cost of debt capital

As the name suggests, is a company's cost of debt the cost it occurs when issuing a bond or taking out a bank loan. These costs occur because the creditors providing the financing, like the equity investors, require compensation for making the debt capital available. One method to estimate these costs is the yield-to-maturity approach. Hereby, it is assumed that a company's before-tax cost of debt can be approximated through the yield that equates to the present value of the future payments of the firm's bond if held to maturity hence the annual return a bond investor earns. As a consequence, solving the following equation delivers the yield to maturity and herewith the estimation for a firms cost of debt capital:

$$P_0 = \frac{PMT_1}{\left(1 + \frac{r_d}{2}\right)} + \dots + \frac{PMT_n}{\left(1 + \frac{r_d}{2}\right)^n} + \frac{FV}{\left(1 + \frac{r_d}{2}\right)^n} = \left(\sum_{t=1}^n \frac{PMT_t}{\left(1 + \frac{r_d}{2}\right)^t} \right) + \frac{FV}{\left(1 + \frac{r_d}{2}\right)^n}$$

where:

P_0 = current market price of the bond

PMT_t = interest payment in period t

Literature review

R_d = the yield to maturity

n = number of periods remaining to maturity

FV = maturity value of the bond

This calculation assumes the bond is paying the coupon semi-annually and reinvestment of the cash flows at a rate of $r_d/2$ (Clayman et al., 2012, pp. 135–136).

Nevertheless, using the yield to maturity of a corporate bond as an estimate for the debt inventor's expected return respectively the firm's cost of debt is only a valid mean in a low-risk environment with little risk of default. Contrarily, if there is the risk of a company defaulting on its debt obligations, its bonds yield to maturity overstates the expected return by the default probability multiplied by the rate of expected loss as displayed in the following equation:

$$\begin{aligned} r_d &= (1 - p)y + p(y - L) = y - pL \\ &= \text{Yield to Maturity} - \text{Prob}(\text{default}) \times \text{Expected Loss Rate} \end{aligned}$$

where:

y = yield to maturity

p = probability of default

L = expected loss in the event of default

Consequently, the rating of corporate bonds and the risk linked to them, which is reflected in its rating, need to be considered if the costs of debt capital are estimated through the yield-to-maturity method. However, in average market sentiment, the expected return of a corporate bond with a good rating presents an equitable estimate for a firm's cost of debt (Berk & Demarzo, 2019, pp. 453–454).

Alternatively, a firm's cost of debt can be approximated via its debt rating. As previously teased, reflects a company's debt rating the risk of that company defaulting on the subsequent debt obligation. Therefore, the yield of bonds with akin ratings and maturities to those of the corporate bond can be used to estimate a firm's cost of debt capital. However, this approach bears the shortcoming that the debt rating is related to a specific debt obligation only and based on factors beyond the mere risk profile of the issuing organization (Clayman et al., 2012, pp. 136–137).

2.5.2 Empirical studies about ESG scores and the cost of debt capital

Similar to the relationship between ESG scores and the cost of equity, the relationship between ESG scores and the other source of capital for a firm, the cost of debt, has attracted the attention of empirical research. Apergis et al. (2022) follow that line of research driven by the central importance of ESG to capital allocation and conducted a study with panel data of S&P 500 firms over the timeframe of 10 years from 01.01.2010 to 31.12.2019. In that study, they investigated if ESG high-scoring firms find themselves with lower spreads and better ratings of their issued bonds compared to their counterparts on the other end of the spectrum i.e., ESG low-scoring companies. Therefore, they specifically investigated the effect of companies' ESG scores on their bond spread for newly issued corporate bonds without securities and paying fixed rates in the primary market only. While incorporating control variables for characteristics of the firm such as the total assets and the interest coverage as well as for the characteristics of the bond, namely time to maturity, issue size, seniority, and rating, they find a significant negative correlation of ESG scores with the bond yields. Consequently, their results provide evidence that the primary market for corporate bond issuances rewards good ESG scores with a lower expected return thus lower cost of debt capital.

Furthermore, the reduction of information asymmetry through disclosure activities benefits firms by lowering their cost of debt as it enables lenders to better assess the default risk (Gerwanski, 2020). Driven by that assertion, further research on ESG scores' impact on a firm's cost of debt capital has been conducted to find whether ESG scores as non-financial disclosure practice reduce the information asymmetry to a relevant extent and thus lower the cost of capital. The used data consists of 8264 observations from the non-financial firms in the S&P 1200 over the time period from 2010 to 2019. Besides, the dependent variable of the research is the annual net weighted average cost of debt financing while the independent variable is the ESG disclosure score of the companies. Moreover, to increase the robustness of the model, the control variables of the company size measured in total assets, the company profitability measured in return on assets, the company's financial leverage, and the interest coverage ratio are incorporated. Eventually, the regression model of the study concludes that ESG disclosure activities have a significant negative impact on a firm's cost of debt capital at the 1% level (Raimo et al., 2021).

Literature review

On the one hand, issuing corporate bonds is a way for companies to finance their operations and projects with debt capital. On the other hand, they can access debt capital by consulting a bank and taking out a bank loan. To better understand whether banks account for their corporate borrowers' ESG respectively CSR activities, an empirical study examined if high CSR levels in firms are rewarded with lower interest rates on their bank loans. Additionally, the study intends to find if CSR performance is as relevant in the case of a low-quality lender as in the case of a high-quality lender. Therefore, the study used the spread over the London Interbank Offer Rate including annual or facility fees paid by the borrower to the lending bank and CSR scores retrieved from KLD. The final dataset excludes firms from the finance and insurance industry and comprises 3996 loans extended to 1265 US companies over the period from 1991 to 2006. In the regression model used in the study, it is controlled for other factors known to influence the loan spread such as the firm size in total assets, the market-to-book ratio, the leverage ratio, and whether the loan is secured. Moreover, it is controlled for profitability measures by incorporating the variables operating income to total assets, taxes to total asset ratios, net working capital to total assets, earnings before interest, and retained earnings to total assets. Additionally, the Altman Z score, bond ratings and whether it represents investment grade, institutional shareholders, and industry dummies are introduced as control variables representing firm characteristics. Similarly, loan maturity, loan concentration, loan type, and a dummy for loan syndication are introduced to incorporate the loan characteristics. Lastly, the model controls for macroeconomic conditions through the three months USD LIBOR rate at the time of issuance. Thereby, the results provide evidence for a significant but economically moderate impact of a firm's CSR performance on its loan spreads. This is especially observable for low-quality borrowers associated with greater CSR concerns who need to pay a higher loan spread compared to those exhibiting less CSR concerns. Nevertheless, CSR performance seems to be subordinate to lenders as they are found to be indifferent in the case of high-quality borrowers (Goss & Roberts, 2011).

An akin study investigating the impact of a firm's environmental profile on their bank loan terms solely finds that those generating revenues from environmentally favorable products pay lower interest rates. This study utilized environmental data retrieved from KLD and bank loan data from the Dealscan database by the Loan Pricing Corporation which yielded a panel data set of 6525 bank loans to non-financial firms from 1990 to

2008. As the dependent variable serves, like in the previously introduced study, the all-in drawn spread. Furthermore, total assets, the leverage ratio, the operating income to total assets ratio, a modified z-score, and dummy variables for debt rating and if it is investment grade are used as control variables for the firm characteristics. The maturity, if performance pricing is incorporated, and whether it is a term loan are used as control variables for the loan characteristics. Lastly, the model delivering mentioned findings of the study controls for macroeconomic factors through the inclusion of the 10-years to 1-year treasury note spreads and the difference between BAA and AAA corporate bonds as well as accounts for year fixed effects, loan purpose indicators, and industry fixed effects (Chava, 2010).

Consequently, gathered literature on empirical investigations of ESG-related performance and a company's cost of debt points toward the same assertion as the literature discussed in the three preceding chapters that a negative relationship between ESG scores and the different components of the cost of capital exists.

2.6 ESG and the weighted average cost of capital

The previous chapters covered the specific components of equity and debt capital costs which combined represent a company's total cost of capital. Moreover, the total cost of capital which is referred to as the weighted average cost of capital is of central importance to this thesis and subject to this chapter. Additionally, this chapter provides a review of the literature investigating the empirical implications of ESG scores on the weighted average cost of capital.

2.6.1 Definition and composition of the weighted average cost of capital

The cost of capital is the compensation investors require to invest in the company and must at least match the return of other investment opportunities on the equal risk level. Furthermore, if a company decides to raise capital, it has to decide on the source of capital. Depending on that decision, the chosen capital source's cost marginally increases the company's funding costs. Therefore, to determine the required return, the marginal cost of the individual funding sources is calculated in the first step followed by computing their weighted average, the weighted average cost of capital (WACC), using the following equation:

$$WACC = w_d r_d \times (1 - t) + w_p r_p + w_e r_e$$

where:

w_d = proportion of debt

r_d = before-tax marginal cost of debt

t = the firm's marginal tax rate

w_p = proportion of preferred stock

r_p = marginal cost of preferred stock

w_e = proportion of equity

r_e = marginal cost of equity

Thereby, the cost of debt is adjusted for the tax deductibility of interest paid on the firm's debt by multiplying r_d by $(1 - t)$ to arrive at the after-tax cost of debt. Moreover, for empirical computations of the weighted cost of capital, the proportions of debt and equity capital need to be known. The best source for these is the company's target capital structure. Yet, this might be information that is contained for firm insiders and thus not known among outsiders requiring alternative paths to be taken. Consequently, it can be assumed that the current market values of debt and equity capital depict the firm's target capital structure. Moreover, trends in and executive statements about the company's capital structure can be incorporated into the derivation of its desired target capital structure. Lastly, using the average of available capital structures of comparable companies has been established as a potential proxy for the subject company's target capital structure (Clayman et al., 2012, pp. 128–131).

2.6.2 Importance of the weighted average cost of capital

As the previous chapter highlighted, is the target capital structure elementary for the calculation of the weighted average cost of capital. Therefore, it displays the result of a firm's capital structure policy meaning their chosen mix of funding sources which is a central topic in corporate finance. The underlying managerial goal for that decision is to maximize the firm's shareholder value. Moreover, the decision has to be made under the circumstances that an increase in leverage initially decreases the weighted average cost of capital due to the tax shield until this favorable effect is outweighed by the cost of

financial distress associated with a higher debt-to-equity ratio. This relates to the mentioned goal of maximizing shareholder value as the turning point not only depicts the minimized weighted average cost of capital but also the maximum obtainable firm value. Eventually, this is also referred to as the trade-off theory in which the WACC is of central importance (Pyles, 2014, pp. 259–267).

The previous section alludes to a relationship between the weighted average cost of a firm and its value. Furthermore, that relationship stems from the role which the WACC plays in the valuation of a firm's stock. Analysts use discounted cash flow models to compute this whereby they often revert to the free cash flow to the firm and the WACC to do so. In that case, the WACC serves as the discount factor implying a lower WACC leads to a greater present value of the firm. Additionally, the weighted average cost of capital can be used in a similar way to make capital-budgeting decisions based on the net present value of given projects. Hereby, the WACC serves as the proxy for the opportunity costs of capital for the considered project under the assumption that the project reflects the company's average project risk (Clayman et al., 2012, pp. 134–135).

Consequently, the weighted average cost of capital is a result of a firm's funding sources and is of central importance to corporate finance as well as the security valuation practice. Against that background, it is of interest which empirical observations can be found regarding a firm's ESG scores and its WACC.

2.6.3 Empirical studies investigating ESG scores' relationship with the WACC

While the impact of ESG scores on the individual constituents of a firm's cost of capital, namely the cost of equity and the cost of debt, have been investigated in various empirical studies, their impact on the weighted cost of capital has less frequently been subject to research. Nevertheless, the available literature trends toward the finding that larger ESG scores have a significant negative relationship with the WACC. Although, Atan et al. (2018) find in their study on the basis of panel data from 2011 to 2013 (respectively from 2010 to 2012 for the ESG scores as they introduced a one-period time lag of the ESG scores) for 54 Malaysian companies that ESG scores exhibit a significant positive impact on the companies' WACC.

Literature review

Supporting the previously mentioned observation of empirical studies finding predominantly a significant negative relationship between ESG scores and the WACC provides Johnson (2020) evidence from a study focused on South Africa. The study used panel data regression analyses based on a total of 478 firm-year observations for the period between 2011 and 2018 and from 68 companies listed on the Johannesburg Stock Exchange. Thereby, the study focused on firms from the consumer goods, healthcare, consumer services, telecommunications, industrials, and technology sectors only. Furthermore, it was controlled for the firm size by incorporating the market capitalization as well as for the leverage by incorporating the debt-to-asset ratio. However, the regression analysis focusing on the sampled firms across mentioned sectors does not provide proof of a significant relationship between ESG scores and the WACC. Only the analysis of the relationship in the consumer goods and services sector finds a significant negative relationship. Contrarily finds the same study supporting evidence for the results from Atan et al. (2018) in the analysis of the industrial sector where a significant positive relationship is reported (Johnson, 2020).

Moreover, a study from Japan empirically investigated the influence corporate social performance has on the cost of capital for firms in the country. In the study, they intend to account for the influence of banking relationships and ownership structure through adequate control variables in addition to those for firm-specific attributes. Besides, the two-stage regression analysis was conducted on the basis of 2680 observations from publicly listed companies in Japan over the period from 2007 to 2013. Eventually, the study finds that good corporate social performance induced by institutional ownership significantly and negatively influences a firm's WACC in Japan (Suto & Takehara, 2017).

In addition to that, a study on whether improved environmental risk management impacts a firm's cost of capital has been conducted. Furthermore, the study investigated the relationship on the basis of US firms listed in the S&P 500 and controlled for the firm's size, leverage ratio as well as industry. Thereby, they conclude the key findings that firms that introduced improved environmental risk management in 2001 reduced their 2002 WACC whereby the relationship between the two variables is statistically significant and negative. Furthermore, they conclude that this is observable due to a decreasing systematic risk profile and lower performance volatility as a consequence of improved environmental risk management which seems to be rewarded with a lower WACC

Literature review

(Sharfman & Fernando, 2008). Environmental risk management per se only affects the E pillar in the broader scope of a company's ESG performance. Nonetheless, the study depicts an adequate assertion of the ESG score's influence on the WACC as environmental risk management is a fundamental driver of such a broad ESG score (Refinitiv, 2022).

In line with the findings from Sharfman & Fernando (2008) and Suto & Takehara (2017) provide Piechocka-Kaluzna et al. (2021) further evidence for a significant negative relationship between ESG scores and the weighted average cost of capital. This finding has been obtained through the determination of Pearson's linear correlation coefficients and multivariate regression with the WACC as the dependent variable and ESG scores, environmental pillar scores, social pillar scores, and governance pillar scores as independent variables across a panel dataset comprising observations from US companies over the timespan from 2016 to 2020.

Finally, this chapter closes the literature review of this master's thesis on "The impact of ESG score on a firm's cost of capital" and akin to the foregoing chapters suggests that good ESG scores can have a significant negative impact on a firm's cost of capital components as well as on the component unifying weighted average cost of capital.

3 Research framework and hypotheses

This chapter intends to lay out how the research framework guided by the assertions from the literature review has been developed and eventually led to the derivation of the hypotheses that are investigated in this thesis.

3.1 Research framework

To answer the research question “*To what extent do ESG scores influence a firm’s cost of capital?*” the research framework shown in Figure 3 has been developed.

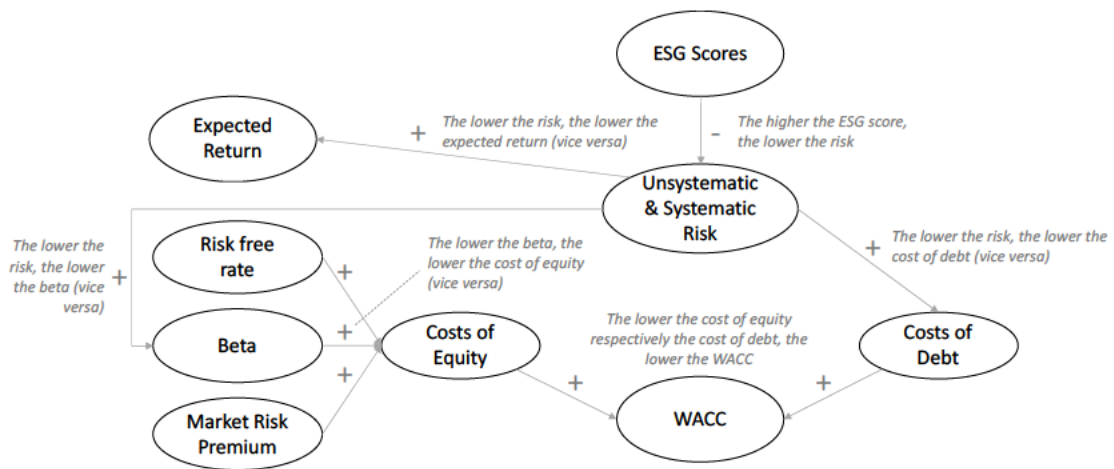


Figure 3: The research framework

Furthermore, the following hypotheses are derived from the framework and subject to research in this thesis.

3.2 Hypotheses

In line with the assertion provided by Sharfman & Fernando (2008) that improved environmental risk management decreases the risk of a company running into ESG-related issues that negatively impact their financial performance as well as Gregory et al. (2014) and Giese et al. (2019) finding companies with good ESG scores to display lower systematic volatility as indicated by their beta factors, hypothesis one (H1) of this research states:

H1: Companies performing well on ESG, represented by higher ESG scores, carry lower systematic risk displayed by lower beta factors.

Research framework and hypotheses

Besides, dependent on the empirical observation that a superior ESG performance has a significant negative relationship with a firm's cost of equity capital (Ng & Rezaee, 2015) and the disclosure of good CSR performance likewise reduces the cost of equity the second hypothesis (*H2*) reads:

H2: Equity capital investors require a lower compensation for their investment in firms with higher ESG scores resulting in lower costs of equity capital.

Additionally, empirical investigations find disclosure activities to reduce the information asymmetry between companies and debt capital providers leading to lower cost of debt for the firms (Gerwanski, 2020). Further, taking this investigation to the realm of ESG disclosure, Raimo et al. (2021) yield congruent findings reporting that companies with higher ESG disclosure scores find themselves with lower costs of debt capital. This assertion of a negative relationship between good ESG performance and the cost of debt capital seems to be found likewise in terms of corporate bond spreads (Apergis et al., 2022) as well as the costs of a corporate bank loan (Chava, 2010). Consequently, hypothesis three (*H3*) claims:

H3: Debt capital providers demand lower compensation for their investment in corporate bonds and loan advancements resulting in a lower cost of debt for firms with higher ESG scores.

Finally, as the assertions of good ESG performance which is reflected in good ESG scores point to a negative relationship between such and a company's risk, cost of equity, and cost of debt, the weighted average of the capital costs should be influenced by ESG scores in a similar manner. Empirical research provides evidence for this conclusion with Johnson (2020) finding a significant negative influence of ESG scores on the weighted average cost of capital for South African companies in the consumer goods and services industry as well as Piechocka-Kaluzna et al. (2021) observing a similar relationship in their investigation of US firms. Consequently, hypothesis four (*H4*) is derived as the following:

H4: As companies with higher ESG scores face lower costs of equity and costs of debt, their weighted average costs of capital are lower.

Research framework and hypotheses

Thereby, the thesis focuses on the nature of the relationship between ESG scores and a company's cost of capital with the core assumption of a negative character. Higher ESG scores should be associated with a lower risk level and cost of capital for the firms. The findings intend to get in line with existing empirical research finding negative relationships between ESG scores and cost of equity respectively cost of debt individually. Furthermore, the conclusions of this thesis shall supplement the state of research to the extent that the impact of a company's ESG score on the effect chain from company risk to its cost of equity, cost of debt, and the weighted average cost of capital is investigated comprehensively for each firm in the sample dataset to gain a full picture of the impact.

Nevertheless, the author considers ESG scores holistically and does not investigate the individual constituent's (environment, social, and governance) influence. Furthermore, a separate investigation of the used ESG scores would go beyond the scope of this thesis which is why a good score is defined according to the score provider's frameworks. Lastly, the research does not specifically consider the panel data companies' business activities and industries but takes a holistic view based on the US-based companies listed in the S&P 500 over the period from 2017 to 2021.

4 Data and research methodology

In order to test previously stated hypotheses within the set scope of this master's thesis, relevant data has been gathered and systematically investigated through regression analyses. Therefore, this chapter sheds light on the panel data used as well as introduces the dependent, independent, and control variables subsequent to the regression models which are elucidated at the end of the chapter.

4.1 Panel data sample

As the research goal of this study defines, the author wants to investigate the relationship between ESG scores and the effect chain from the company risk profile to all dimensions of a firm's cost of capital, namely the cost of debt, cost of equity, and eventually the weighted average cost of capital. Furthermore, the intention is to do so across a wide panel data set while considering ESG scores holistically and not considering the firm's industry except for the financial sector. Consequently, to test the four developed hypotheses, a data set of companies that are publicly traded and thus are required to report and publish data on financial but also environmental, social, and governance performance is needed. Firms listed in the S&P 500 fulfill this requirement which is why the index has been selected as the basis for the panel data of this research. Moreover, this approach is in line with previous research within the realm of ESG performance's influence on a firm's cost of capital (Sharfman & Fernando, 2008). Nevertheless, the constituent list of the S&P 500 comprising 503 common stocks has been filtered for companies with their headquarters in the United States of America which shall allow for better comparability in terms of financial as well as environmental, social, and governance laws and regulations. Additionally, a filter for the listed stocks' Global Industry Classification Standard (GICS) has been applied and 67 firms from the financial sector including banks, diversified financials, and insurance companies have been ruled out of the initial dataset. That is congruent with the work of other researchers in this area and comes down to the sector-specific regulations as well as the lacking comparability regarding access to and conditions of external financing which eventually is reflected in the cost of capital (Raimo et al., 2021).

The above-described filter operations were executed in the Refinitiv terminal using the Screener App and resulted in a screen comprising 414 stocks of companies headquartered

Data and research methodology

in the United States which's business operations are outside of the financial sector as defined by the Global Industry Classification Standard. This screen was downloaded to an MS Excel file on May 14th, 2023, and served as the basis for the further construction of the panel data. Finally, this panel dataset was constructed using the Formula Builder of the Refinitiv 365 MS Excel plug-in through which the relevant data for the chosen dependent variables beta, cost of debt, cost of equity, and the weighted average cost of capital as well as for the independent interest variables ESG Score and the control variables total assets, total debt to total equity ratio, return on assets, and price-to-book value per share were retrieved. Thereby, the investigated time period spans from 2017 to 2021 and the retrieved data are as of the year ends and were too fetched from the Refinitiv database on May 14th, 2023.

Eventually, an unbalanced panel data set with 1750 observations for the variable with the lowest count of observations and 2046 for the one with the highest count of observations was created. In order to proceed with the investigation of the research question *“To what extent do ESG scores influence a firm's cost of capital?”*, the panel data was further prepared using various operations from the Python libraries run on the web-based computing platform Jupyter Notebook. Firstly, as suggested in previous related empirical investigations of the relationship between ESG-relevant topics and a firm's cost of capital, the natural logarithm of the total assets fetched in USD from the Refinitiv database was taken to normalize the data (Chava, 2011; El Ghouli et al., 2011). Secondly, to mitigate the impact of outliers in the panel data set, a winsorization with a 5% trimming on both tail ends was performed. Lastly, the panel data set was screened for missing values whereby year observations with a missing value for any of the variables relevant to the regression models were deleted which finally led to a balanced panel data set with 1625 observations from 355 unique stocks listed in the S&P 500 over the time period from 2017 to 2021.

Of these 355 unique stocks, 17% are from the Industrials, 15% from Health Care, 14% from Information Technology, 12% from Consumer Discretionary, 10% from Consumer Staples, 8% from Utilities, 7% from Real Estate, 6% from the Materials, 6% from Energy, and 5% from Communication Services Sector as defined by the Global Industry Classification Standard. Figure 4 depicts the distribution of GICS sectors across the balanced panel data set in absolute figures.

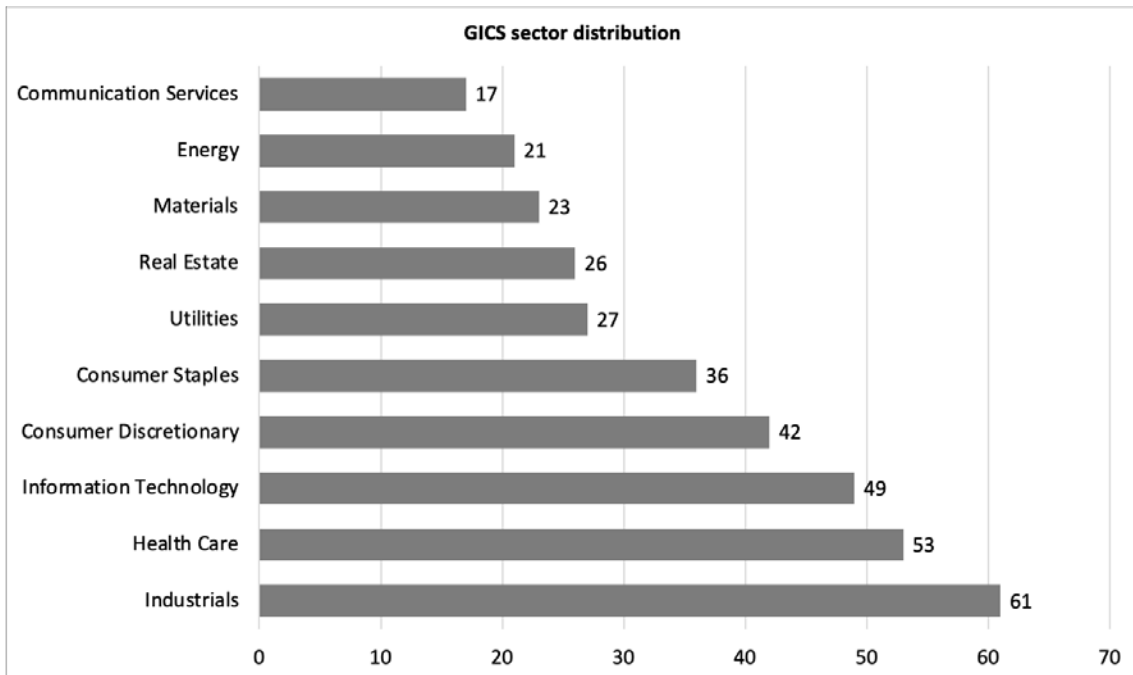


Figure 4: Distribution of GICS sectors across the balanced panel data set (absolute figures)

Furthermore, Figure 5 displays the total count distribution of the five relevant years across the total 1625 observations in the panel data set.

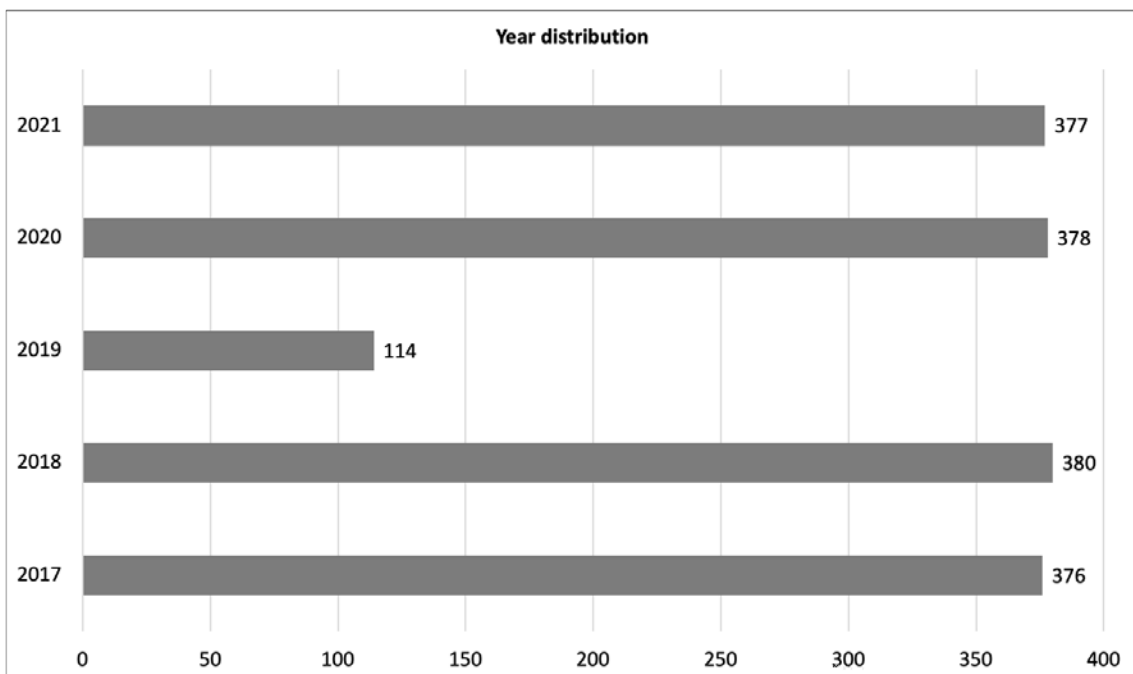


Figure 5: Distribution of years for all 1625 observations

4.2 Dependent variables

Central to the research conducted in this thesis are the four hypotheses presented in sub-chapter 3.2. Moreover, each of the hypotheses is tested with a dedicated regression model and subsequent dependent variables. These variables shall be introduced in the following sub-chapter.

4.2.1 The beta factor

The beta factor as defined under 2.2.1 displays the co-movement of a company's stock compared to the market movement as a whole and thereby a measure of the non-diversifiable systematic risk inherent to a firm's publicly traded security (Reilly & Brown, 2012, p. 20). Therefore, it has been chosen as an adequate dependent variable to test hypothesis H1. Hence, the CAPM Betas from the last trading day of each relevant year were fetched from the Refinitiv database to construct the panel dataset.

4.2.2 The cost of equity

The firm's cost of equity capital has been selected as the response variable for the regression model to test hypothesis H2. Consequently, the costs of equity as of the last trading day of each relevant year for the firms in the panel data were retrieved from Refinitiv. Hereby, Refinitiv calculates the cost of equity by multiplying the market equity risk premium with the sum of the stock's beta and an inflation-adjusted risk-free rate (Refinitiv, n.d.).

4.2.3 The cost of debt

The third hypothesis H3 is tested with the cost of debt capital as the dependent variable. In order to do so, the relevant data as the panel data firm's cost of debt as of the last trading year over the period from 2017 to 2021 was extracted from the Refinitiv database. Thereby, the Refinitiv Workspace calculates the marginal cost of issuing new debt for the companies by summing up the weighted cost of short-term debt and the weighted cost of long-term debt relying on the respective 1-year and 10-year points of an adequate credit curve (Refinitiv, n.d.).

4.2.4 *The weighted average cost of capital*

Eventually, the weighted average cost of capital has been determined as the dependent variable for the fourth hypothesis H4. Similar to the other three dependent variables have the weighted average costs of capital for the firms in the panel data set been fetched from the Refinitiv Workspace through the Formula Builder of the MS Excel Refinitiv 365 plugin. The data is calculated based on the proportionate weighting of all sources of a firm's capital, namely equity stock, preferred stock, and debt. These weighted costs of capital have been collected as of the last trading date of the considered five-year time period.

4.3 The ESG Score as the interest variable

One core element of the empirical investigation of this master's thesis is the firm's ESG Score as the interest variable being used in each of the four regression models subsequent to this work. Akin to all other variables, the ESG scores have been drawn from the Refinitiv database where they are described as "an overall company score based on the self-reported information in the environmental, social, and corporate governance pillars" (Refinitiv, n.d.). The author regards the ESG scores provided by Refinitiv as an adequate measure for a firm's ESG performance as on the one hand previous related research reverted to these scores (Aydoğmuş et al., 2022; Duque-Grisales & Aguilera-Caracuel, 2021; Giannopoulos et al., 2022) and on the other hand, Refinitiv provides a leading ESG database with historical data tracing back more than 20 years, comprising 630 ESG metrics and 85% of the global market capitalization (Refinitiv, 2022).

The quality of Refinitiv's ESG scores stems from a profound data basis and processing in which more than 700 research analysts collect ESG data from various sources such as company websites, annual reports, NGO websites, stock exchange filings, news sources, CSR reports, and update the database continuously. Moreover, to ensure the quality of the data, they leverage algorithmic and human processing throughout the data entry and post-production as well as through independent audits and management reviews. Additionally, as the panel data on which the research in this study is based consists of constituents of the S&P 500, it is favorable that the index is covered and reviewed quarterly by Refinitiv since 2003.

Data and research methodology

Eventually, the Refinitiv ESG score is a transparent and data-driven assessment of a firm's ESG performance that takes into account industry materiality and firm size biases. Hereby, the structure of the ESG score is firstly capturing and calculating more than 630 company-level ESG measures resulting in 186 most comparable and material metrics for each industry. In the following step, these metrics are transformed into ten category scores across the pillars of environmental (resource use, innovation, and emission), social (community, workforce, product responsibility, and human rights), and governance (CSR strategy, management, and shareholders). Additionally, these ten category scores are assembled into E, S, and G pillar scores by summing them up with category weights for environmental and social to account for industry specifics before normalizing them to arrive at percentage scores from 0 to 100. Similarly, the overall ESG score is the sum of a firm's category scores proportionally weighted with their industry's category weights (Refinitiv, 2022).

Ultimately, the following Table 1 depicts Refinitiv's ESG score ranges and the related descriptions to derive conclusions on the rated firm's ESG performance from the provided scores.

Table 1: ESG score range and description (Refinitiv, 2022)

Score range	Description
From 0 <= to <= 25	Indicates poor relative ESG performance and insufficient degree of transparency in reporting material ESG data publicly.
From 25 < to <= 50	Indicates satisfactory relative ESG performance and moderate degree of transparency in reporting material ESG data publicly.
From 50 < to <= 75	Indicates good relative ESG performance and above average degree of transparency in reporting material ESG data publicly.
From 75 < to <= 100	Indicates excellent relative ESG performance and high degree of transparency in reporting material ESG data publicly.

By incorporating the Refinitiv ESG score in the four regression models investigating the hypotheses of this study, the author expects the regression coefficient of the ESG score

as the interest variable to display a negative relationship with all four dependent variables beta, cost of equity, cost of debt, and the weighted average cost of capital.

4.4 Control variables

To enhance the validity, accuracy, and reliability of the four regression models central to this thesis, control variables have been incorporated. Hence, this sub-chapter introduces these control variables and discusses their impact on the model as expected by the author. Thereby, the relevant data for each of the control variables have been obtained from Refinitiv for the considered time period's year ends.

4.4.1 *Ln total assets*

The Refinitiv database from which the data on total assets for each observation have been fetched, defines total assets as “anything tangible or intangible that can be owned or controlled to produce value and that is held by a company to produce positive economic value” (Refinitiv, n.d.). Thereby, it is measured in US dollars.

Total assets are used as a control variable in line with previous research in the field (Gerwanski, 2020) to control for the firm's size as it is found that larger firms tend to have lower costs of capital and attract more stakeholder attention (Gebhardt et al., 2001) as well as having more resources available which increases their ESG engagement and lowers their default risk (Barclay et al., 2003; Gong et al., 2018; Guidara et al., 2014). Thereby, the fetched raw data has been transformed by taking the natural logarithmic which is congruent to related empirical studies and intends to prevent skewness in the data (Bauer & Hann, 2010).

Consequently, the author expects the ln total assets as a control variable for the firm's size to have a negative relationship with each of the dependent variables as a larger size is associated with lower risk levels and lower cost of capital.

4.4.2 *Leverage ratio*

The data provider defines the leverage ratio used in this work as the ratio of total debt divided by the value of the total shareholder equity multiplied by 100 (Refinitiv, n.d.).

The incorporation of the leverage ratio as a control variable is inspired by the literature reviewed for this thesis and is rooted in the empirical findings that higher leverage ratios are positively related to the risk of firms defaulting on their debt obligations (Zhu, 2014) and that a higher leverage ratio leads to increased disclosure of ESG information due to increased scrutiny from financial institutions (Lanis & Richardson, 2012). Nevertheless, the leverage ratio depicting a source of long-term financial risk is known to affect a firm's cost of equity and cost of debt by theoretically increasing them marginally but decreasing their weighted average (WACC) due to the tax shield and usually lower cost of debt until a certain threshold is exceeded (Modigliani & Miller, 1958). Moreover, empirical research provides evidence that a company's leverage ratio has a negative relationship with its weighted average cost of capital (Sharfman & Fernando, 2008) while contributing to an increase in the cost of debt (Goss & Roberts, 2011) as well as the cost of equity capital (Ng & Rezaee, 2015). Lastly, considering the influence of leverage on the beta factor, empirical evidence suggests that an increase in the leverage ratio leads to an increase in the equity beta (Baker et al., 2020)

Consequently, the author expects the leverage ratio as a control variable to have a negative relationship with the weighted average cost of capital but a positive relationship with the cost of debt, cost of equity and the beta factor.

4.4.3 Return on assets

Refinitiv as the source of data for return on assets as a control variable defines it as a measure of a company's operating efficiency regardless of the magnitude of its leverage ratio and calculates it "by dividing a company's net income prior to financing costs by total assets" (Refinitiv, n.d.).

Moreover, the return on assets serves as a proxy for a company's profitability. Therefore, this control variable has been introduced to the regression equations in this master's thesis which is congruent with akin empirical research (Gerwanski, 2020; Raimo et al., 2021). The rationale behind this practice is that profitable firms are associated with lower default probabilities (Graham et al., 2008) and are expected to occur fewer frictions in the financial markets in general (Cheng et al., 2014). Besides, the work of Ng & Rezaee (2015) alludes that more profitable firms face lower costs of equity capital. Additionally,

Data and research methodology

a further empirical investigation finds an inverse relationship between a firm's profitability and its return sensitivity (Hao et al., 2011).

Against the background of these assertions, the author expects the return on assets as a control variable to demonstrate a negative relationship with the dependent variables of the four regression equations central to this study.

4.4.4 Price-to-book value

The source of the data calculates the price to book value "by dividing the company's latest closing price by its book value per share. Book value per share is calculated by dividing total equity from latest fiscal period by current total shares outstanding" (Refinitiv, n.d.).

The price-to-book value depicts how the market values a firm's equity compared to the self-attributed value of the firm. Therefore, a low price-to-book value could imply financial distress wherein the meaningfulness of the ratio regarding the firm's cost of capital as well as riskiness lies (Berk & Demarzo, 2019). Eventually, the incorporation of the ratio as a control variable to investigate the impact of ESG scores on a firm's cost of capital is congruent with akin research performed by Suto & Takehara (2017).

Finally, the author expects this control variable to have an inverse relationship with the dependent variables subject to investigation through regression analyses.

Data and research methodology

To summarize this sub-chapter 4.4 and before discussing the descriptive statistics, Figure 6 extends the research framework (Figure 3) by the control variables including arrows indicating the nature of their expected influence on the dependent variables beta, cost of equity, cost of debt, and the weighted average cost of capital.

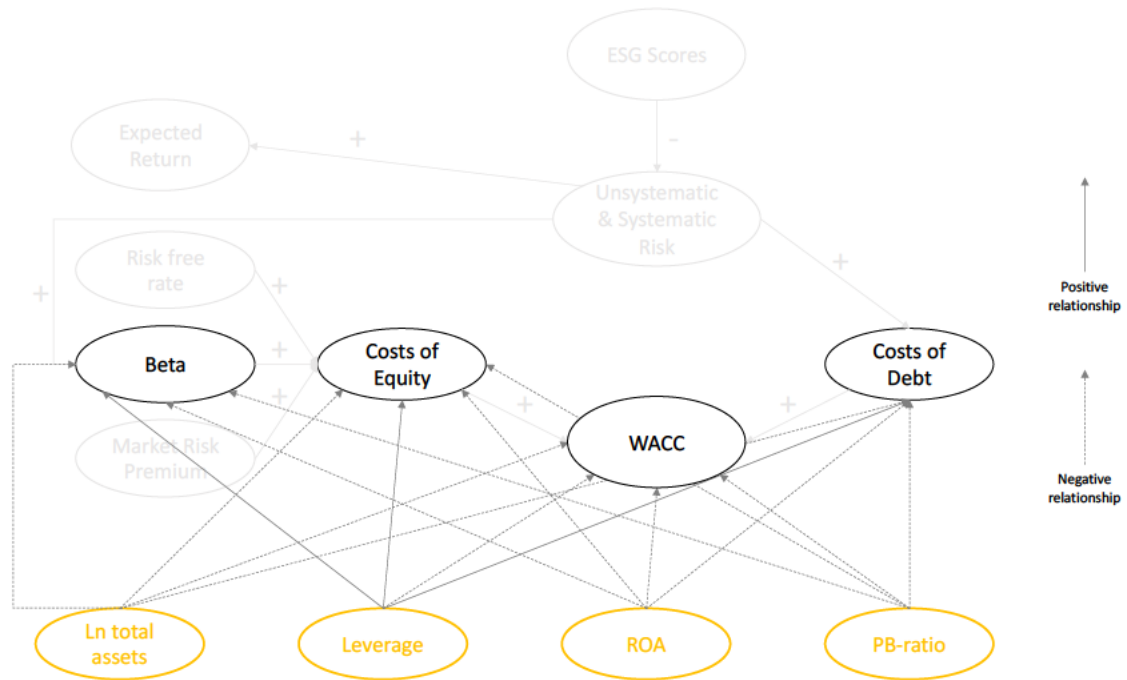


Figure 6: The expected influence of the control variables on the dependent variables

4.5 Regression models

In order to arrive at meaningful results by performing regression analyses with the panel data obtained from Refinitiv, a regression equation for each of the hypotheses to be tested was developed. Thereby, the following four regression models have been used to investigate the four hypotheses central to this study.

Hypothesis one (H1) is that: “*Companies performing well on ESG, represented by higher ESG scores, carry lower systematic risk displayed by lower beta factors.*” and has been tested with the following regression model (Model 1).

$$\begin{aligned} \text{Beta}_{i,t} = & \beta_0 + \beta_1 \times \text{ESG Score}_{i,t} + \beta_2 \times \text{Ln total assets}_{i,t} + \beta_3 \times \text{Leverage}_{i,t} \\ & + \beta_4 \times \text{ROA}_{i,t} + \beta_5 \times \text{PB - ratio}_{i,t} + \varepsilon_{i,t} \end{aligned}$$

Besides, hypothesis two (H2) reads: “*Equity capital investors require a lower compensation for their investment in firms with higher ESG scores resulting in lower costs of equity capital.*” and has been investigated with the following regression model (Model 2).

$$\begin{aligned} \text{CoE}_{i,t} = & \beta_0 + \beta_1 \times \text{ESG Score}_{i,t} + \beta_2 \times \text{Ln total assets}_{i,t} + \beta_3 \times \text{Leverage}_{i,t} \\ & + \beta_4 \times \text{ROA}_{i,t} + \beta_5 \times \text{PB - ratio}_{i,t} + \varepsilon_{i,t} \end{aligned}$$

Moreover, hypothesis three (H3) states: “*Debt capital providers demand lower compensation for their investment in corporate bonds and loan advancements resulting in a lower cost of debt for firms with higher ESG scores.*” and has been researched with the following regression model (Model 3).

$$\begin{aligned} \text{CoD}_{i,t} = & \beta_0 + \beta_1 \times \text{ESG Score}_{i,t} + \beta_2 \times \text{Ln total assets}_{i,t} + \beta_3 \times \text{Leverage}_{i,t} \\ & + \beta_4 \times \text{ROA}_{i,t} + \beta_5 \times \text{PB - ratio}_{i,t} + \varepsilon_{i,t} \end{aligned}$$

Finally, hypothesis (H4) asserts: “*As companies with higher ESG scores face lower costs of equity and costs of debt, their weighted average costs of capital are lower.*” and has been probed with the following regression model (Model 4).

Data and research methodology

$$WACC_{i,t} = \beta_0 + \beta_1 \times ESG\ Score_{i,t} + \beta_2 \times Ln\ total\ assets_{i,t} \\ + \beta_3 \times Leverage_{i,t} + \beta_4 \times ROA_{i,t} + \beta_5 \times PB - ratio_{i,t} + \varepsilon_{i,t}$$

Where for all models:

Beta = the firms' stock's beta factor

CoE = the firms' cost of equity capital

CoD = the firms' cost of debt capital

WACC = the firms' weighted average cost of capital

ESG Score = the firms' ESG score

Ln total assets = the natural logarithm of the firms' total assets

Leverage = the firms' leverage ratio

ROA = the firms' return on assets

PB-ratio = the firms' price-to-book value

ε = the error term

i,t = represents the identifier for the individual firm observation (*i*) in the specific year (*t*)

4.6 Model specifications

Furthermore, the regression analyses were systematically approached, and adequate statistical tests of the interim results were conducted. Thereby, this chapter intends to granularly outline the procedure leading to robust regression models.

4.6.1 OLS regressions and the distribution of residual errors

The first step of the performed procedure was to run ordinary least square regression analyses with each of the four models to establish a basis for further analysis. After obtaining the results of the OLS regressions, the residual errors were investigated to draw conclusions about whether the results for the interest variable were meaningful. Therefore, quantile-quantile plots for the residual errors of each OLS regression were plotted to check for normal distribution graphically. Figure 7 shows the QQ plots for each of the four regression models. Thereby, all four QQ plots clearly display deviations from the straight diagonal line which indicates that the residual errors are not normally distributed.

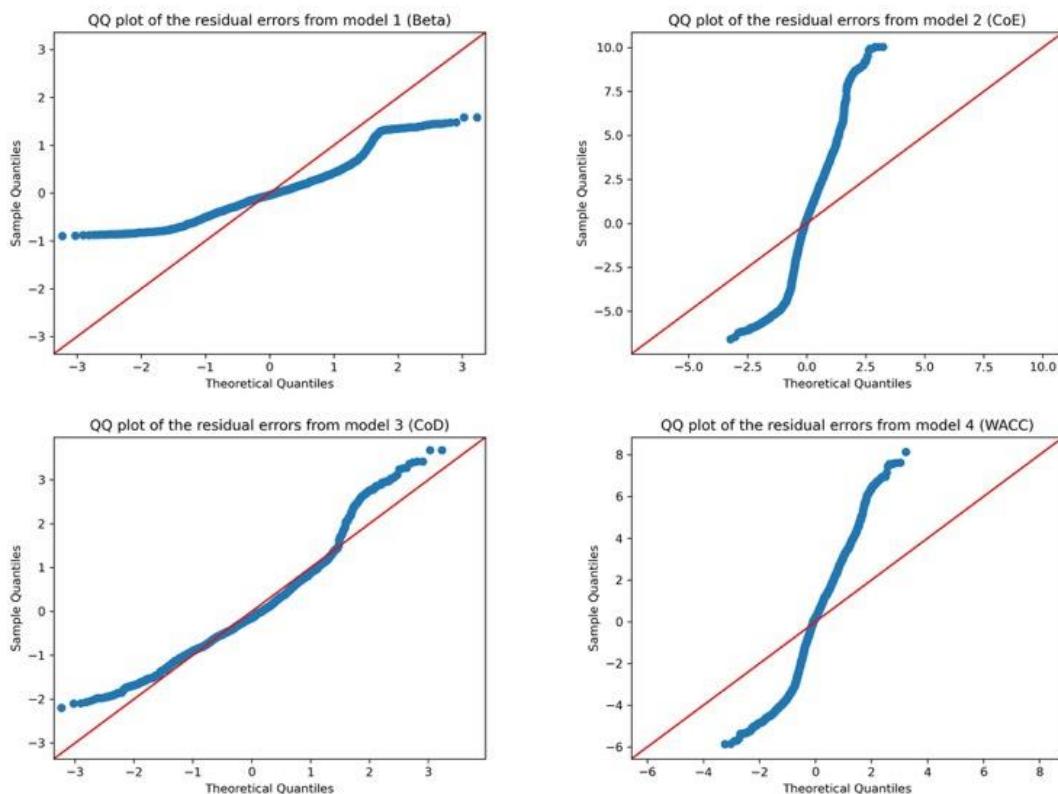


Figure 7: QQ plots of the residual errors from the OLS regression results

Furthermore, this observation of non-normality is backed by the output of the Omnibus test and the Jarque-Bera test presented in Table 2.

Table 2: Omnibus and Jarque-Bera test results for the residual errors of the OLS regressions

	Model 1 (Beta)	Model 2 (CoE)	Model 3 (CoD)	Model 4 (WACC)
Omnibus test	138.473	62.658	193.620	99.664
<i>p-value</i>	<i>0.000</i>	<i>0.000</i>	<i>0.000</i>	<i>0.000</i>
Jarque-Bera test	176.467	42.514	285.391	42.080
<i>p-value</i>	<i>4.79e-39</i>	<i>5.87e-39</i>	<i>1.07e-62</i>	<i>7.28e-10</i>

As high values for the Omnibus statistic indicate greater deviation from normality and associated p-values below the threshold of 0.05 suggest rejecting the null hypothesis of normal distribution, the test results support what can be visually observed in the QQ plots. Moreover, the high values for the Jarque-Bera test statistic and their subsequent p-values close to zero provide further evidence for the non-normality of the residual errors in each of the OLS regressions (Date, n.d.).

4.6.2 *White test to check for homoscedasticity in the residual errors*

Besides, as a next step in the iterative process to arrive at valid and meaningful regression analyses, the residual errors of the OLS regressions have been checked for homoscedasticity. White tests regressing the square of the residual errors on the independent variables have been performed to do so. Hence, the null hypothesis of the residuals being homoscedastic was tested (Date, n.d.). The consequent White test results are gathered in the following Table 3.

Table 3: White test results for the residual errors of the OLS regressions

	Model 1 (Beta)	Model 2 (CoE)	Model 3 (CoD)	Model 4 (WACC)
Lagrange Multiplier statistic	218.992	142.365	173.349	94.870
<i>p-value</i>	<i>1.89e-35</i>	<i>1.81e-20</i>	<i>1.93e-26</i>	<i>1.03e-11</i>
F-statistic	12.491	7.701	9.577	4.973
<i>p-value</i>	<i>4.79e-39</i>	<i>5.87e-39</i>	<i>1.07e-62</i>	<i>7.28e-10</i>

The results for the Lagrange Multiplier statistic of the OLS regressions across all four models are decisively above the critical value of 15.0863 and come along with a p-value suggesting significance at the 1% level which suggests rejecting the null hypothesis of homoscedasticity. Additionally, the F-statistic results are congruent with the suggestion

to reject the assumption of homoscedasticity with values greater than the critical value of 3.0285 and p-values below the 1% significance threshold.

4.6.3 Durbin-Watson test to check for autocorrelation in the residual errors

The last test performed to investigate the residual errors of the OLS regression analyses was the Durbin-Watson test to check whether there is autocorrelation within them. Table 4 presents the test statistic results for each of the four models. These generally range between 0 and 4 with a value of 2 indicating no autocorrelation while values closer to the range ends suggest the presence of autocorrelation (Greene, 2003, p. 270). With 1625 observations and a desired significance level of 1%, the critical value for the Durbin-Watson test statistics ranges from 1.727 to 1.785. Consequently, the presence of autocorrelation can be observed across all four models with a significance at the 1% level although the test statistic of models two and four are relatively close to the critical value range which hints to only a weak autocorrelation in their respective residual errors.

Table 4: Durbin-Watson test statistic results and critical value range

	Model 1 (Beta)	Model 2 (CoE)	Model 3 (CoD)	Model 4 (WACC)
Durbin Watson test	0.792	1.612	1.316	1.587
<i>Critical value range</i>	<i>[1.727,1.788]</i>			

4.6.4 Hausman test to decide on fixed effect or random effect regression analyses

Recapitulating the previous three sections, the residual errors of the four OLS regression analyses have been found to be not normally distributed, heteroscedastic, and autocorrelated. Consequently, key assumptions of the ordinary least square regression analysis are violated meaning this type of regression analysis is not suited to investigate the panel data. Therefore, fixed effect and random effect regression analyses for all four models have been run as both regression types are known to be adequate tools in panel data analysis and handling heterogeneity. Finally, a Hausman test for each of the four regression models central to this thesis has been performed to decide whether the fixed effect or random effect regression analysis is more appropriate.

The Hausman test is based on the null hypothesis that individual-specific effects are uncorrelated with the independent variables, thus the random effect assumption is correct, and the estimates from the random effect regression analysis are consistent and efficient. Nevertheless, if the underlying test statistic is statistically significant, it is suggested to reject the null hypothesis and the fixed effect regression is more appropriate.

Table 5: Hausman test results for the four regression models

	Model 1 (Beta)	Model 2 (CoE)	Model 3 (CoD)	Model 4 (WACC)
Hausman test (Chi²)	80.743	224.192	173.516	269.827
<i>p-value</i>	5.86e-16	1.87e-46	1.31e-35	3.05e-56

Considering the results (Table 5) from the Hausman test for the four central regression models investigating the relationship between a firm's ESG scores and its beta, cost of equity, cost of debt, and the weighted average cost of capital respectively, fixed effect regression analysis is the appropriate method to perform such an investigation for each of the models. That is because the p-values indicate a statistical significance at the 1% level meaning unobserved heterogeneity is correlated with the independent variables which can be better addressed with the fixed effect regression analysis (Greene, 2003, pp. 301–303).

Eventually, choosing the fixed effect regression analysis to answer the research question: “*To what extent do ESG scores influence a firm's cost of capital?*” is congruent with related research in the field (Ng & Rezaee, 2015; Raimo et al., 2021).

4.7 Robustness test designs

Robustness tests for each of the four regression models have been performed to check whether their results hold true under different model specifications. Therefore, the three executed robustness test approaches are briefly introduced in this sub-chapter.

4.7.1 Excluding the year 2020

On March 11th, 2020, the WHO declared Covid-19 a pandemic that caused quarantine orders and lockdowns across the globe (*CDC Museum COVID-19 Timeline*, n.d.). Considering the impacts of these measures through the lens of the S&P 500 only, significant volatility with an initial drop of 25% in March has been observed in 2020 (Curto & Serrasqueiro, 2022). Consequently, the first robustness test aims to exclude this volatility by dropping the observations from 2020 leading to a reduced panel data set with a total of 1247 observations for each of the variables used.

4.7.2 Excluding ESG Score as an independent variable

The rationale for excluding the ESG Score as the interest variable from the four models of interest lies within the approach of a hierarchical regression. By such measure, comparing the R^2 of each of the models excluding the ESG Score with the R^2 of those including the ESG Score allows one to draw conclusions on the marginal predictive contribution of the interest variable. This approach is in line with related research (Sharfman & Fernando, 2008) and expects including the ESG Score to yield a higher R^2 in each of the four models.

4.7.3 Replacing ESG Score with a dummy variable

In this robustness test, the ESG Score has been replaced with a dummy variable with the value of 1 if an observation's respective ESG Score value is larger than the median of 67.1096 across all observations. On the other hand, if the ESG Score value of an observation is below the median, the dummy variable equals 0. This procedure is subsequent to the assumption that an ESG score greater than the median is relatively high due to being larger than the scores of half the observations in the panel dataset (Khosravi & Wadman, 2022). Assuming so, the relationships between the dummy ESG Score and the dependent variables of the regression models should be congruent with those of the actual ESG Score and the dependent variables in the main regression models.

5 Empirical results

In this chapter, the descriptive statistics and a Pearson correlation matrix for the relevant variables, as well as the results of the fixed effect regression analyses investigating the impact of a firm's ESG score on its beta factor, cost of equity, cost of debt, and the weighted average cost of capital, are reported. Thereby, the results of the performed robustness tests are presented together with the main results to allow for an assessment of their reliability and validity.

5.1 Descriptive statistics

Table 6 presents an overview of the descriptive statistics for the data used in the regression analyses of this study. Thereby, Table 6 displays the mean, standard deviation, minimum, maximum, and 25th, 50th, and 75th percentile for all the variables across a total of 1625 observations for each.

Table 6: Descriptive statistics of the used variables

<i>Dependent variables</i>								
	Observations	Mean	Std. Dev.	Min.	Q1	Q2 (Median)	Q3	Max.
Beta	1625	1.08	0.52	0.26	0.74	1.05	1.33	2.46
CoE	1625	6.66	3.88	1.52	2.78	6.97	9.21	15.30
CoD	1625	2.61	1.05	0.84	1.92	2.45	3.09	5.54
WACC	1625	5.81	3.11	1.54	2.74	6.07	8.11	12.21
<i>Interest variable</i>								
	Observations	Mean	Std. Dev.	Min.	Q1	Q2 (Median)	Q3	Max.
ESG Score	1625	64.41	15.04	34.27	53.74	67.11	76.14	93.69
<i>Control variables</i>								
	Observations	Mean	Std. Dev.	Min.	Q1	Q2 (Median)	Q3	Max.
Ln total assets	1625	23.71	1.10	21.68	22.89	23.68	24.47	25.98
Leverage	1625	186.91	1114.90	4.60	45.36	80.09	139.88	42210.00
ROA	1625	9.14	6.37	1.11	4.28	7.50	12.40	26.01
PB-ratio	1625	6.85	7.65	-4.52	2.23	4.07	7.84	33.53

In terms of the dependent variables, the beta factor across the panel data ranges between 0.26 and 2.46 with a mean of 1.08 and a median of 1.05. Moreover, the firms listed in the S&P 500 over the period from 2017 to 2021 appear to face costs of equity from 1.52% to 15.3% while the mean sits at 6.66% and the median at 6.97%. Additionally, the lowest cost of debt is 0.84% while the highest is 5.54% with a mean of 2.61% and a median of 2.45%. Eventually, the WACC emerges to be 1.54% at the minimum and 12.21% at the maximum with a mean of 5.81% and a median of 6.07% in between.

Empirical results

Furthermore, the ESG score as the interest variable is of central importance to this research. It is observed that the firms in the panel data on average obtain an ESG score of 64.41 with the median sitting at 67.11. Looking at the maximum as well as minimum scores, one finds them at 93.69 which is classified as exceptional relative ESG performance respectively at 34.27 which is classified as tolerable relative ESG performance (Refinitiv, 2022).

Lastly, considering the control variables, leverage stands out due to its high standard deviation and the large distance between its minimum at a leverage ratio of only 4.6% and the maximum ratio at 42'210% even after accounting for outliers through winsorization.

5.2 Pearson correlation matrix

Before proceeding with the regression analyses, the final panel data were analyzed by utilizing the Pearson correlation matrix. The rationale behind that intermediate step was to draw a picture of the magnitude and direction of the relationships between the relevant variables upfront.

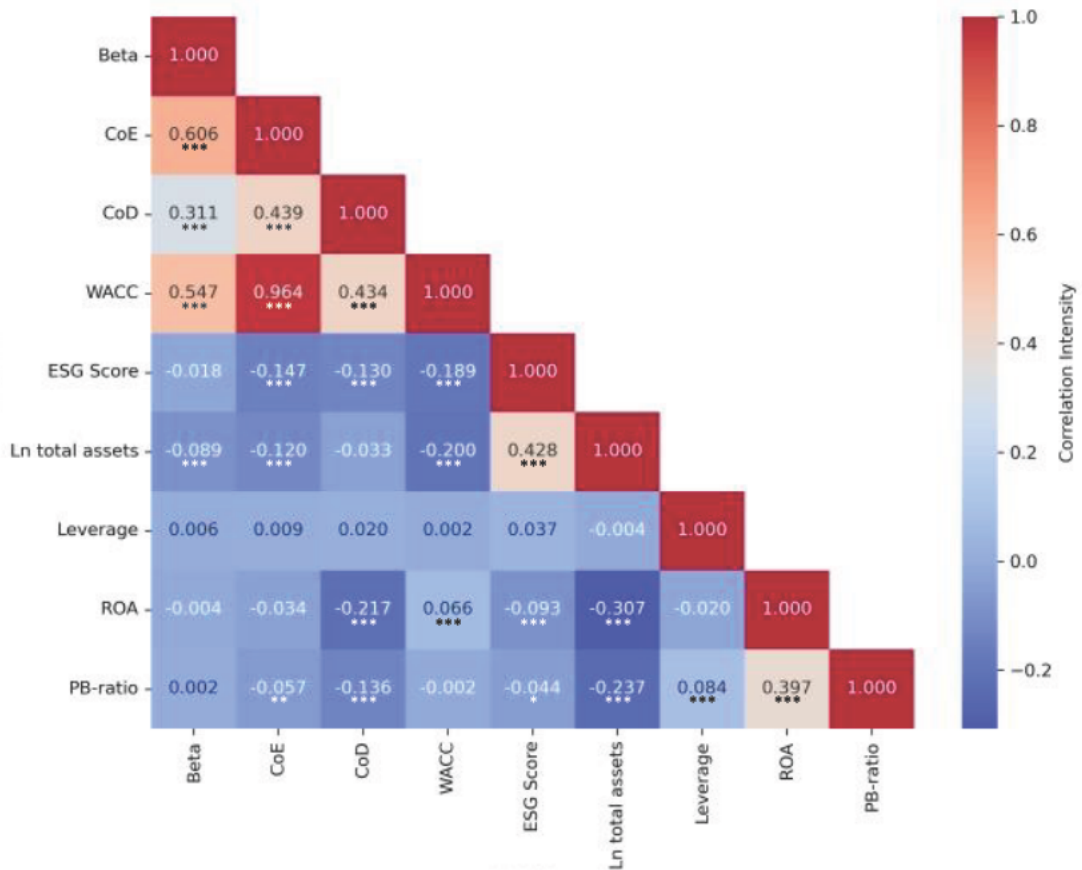


Figure 8: Pearson correlation heatmap matrix of the variables used. ***, **, and * indicate statistical significance at a p-value of less than 1%, 5%, and 10% respectively.

Figure 8 displays the results of the Pearson correlation matrix in a heatmap including both the correlation coefficient and the corresponding significance level. Moreover, the color of the boxes containing the values indicates the magnitude of the correlation between the considered variables.

The independent variables Beta, CoE, CoD, and WACC show a relatively strong and statistically significant relationship at the 1% level. That is not a surprise since they are partly driven by the same drivers or even highly relevant drivers for the calculation of one another such as Beta for the CoE as well as CoE and CoD as the main input

Empirical results

parameters for the WACC. On the other hand, the pair-wise correlations between the dependent variables and the control variables are found to be low to moderate with those of Beta and Ln total assets, CoE and PB-ratio respectively Ln total assets, CoD and PB-ratio respectively ROA as well as WACC and ROA respectively Ln total assets exhibiting statistical significance.

Besides, the interest variable ESG Score appears to have relationships with the dependent variables as expected. The correlation coefficients are all moderately negative and statistically significant at the 1% level for CoE, CoD, and the WACC while no significance can be assigned to the observed relationship with Beta.

Considering the independent variables comprising the interest variable and the control variables Ln total assets, Leverage, ROA, and PB-ratio, the strength of the relationships is vastly observed to be on very low to moderate levels. Solely, the relationships between Ln total assets and ESG score as well as between the PB-ratio and ROA are slightly higher with coefficients of 0.428 and 0.397 respectively. Moreover, these relationships are significant at the 1% level. This observation could be explained due to larger firms as measured by total assets might have more resources to implement and report on ESG-related matters and markets pricing more profitable firms as measured by ROA higher. Nonetheless, multicollinearity does not oppose a concern for the regression analyses because the holistic result of the Pearson correlation matrix heatmap is not displaying concerningly high correlation coefficients between the explanatory variables.

5.3 Results for Model 1 investigating the ESG score's impact on beta

Table 7 presents the results of the fixed effect regression analysis of Model 1 as well as the results for the robustness tests.

Table 7: Fixed effect regression result for Model 1 including robustness tests. ***, **, and * indicate statistical significance at a p-value of less than 1%, 5%, and 10% respectively.

<i>Beta as the dependent variables</i>					
	<i>Expected direction</i>	Model 1	Without 2020	Excl. ESG Score	Dummy ESG Score
ESG Score	(-)	-0.0008	-0.0009	n.a.	-0.0010
Ln total assets	(-)	-0.1212***	-0.1189***	-0.1258***	-0.1256***
Leverage	(+)	-3.522e-07	-6.532e-07	-4.002e-07	-4.014e-07
ROA	(-)	0.0017	0.0042	0.0017	0.0017
PB-ratio	(-)	0.0098***	0.0107***	0.0097***	0.0097***
No. of obs.		1625	1247	1625	1625
R ²		0.0526	0.0604	0.0522	0.0522
F-statistic		14.001***	11.348***	17.390***	13.901***

Thereby, Model 1 and the robustness test regressions are significant at the 1% level. Moreover, the results for Model 1 suggest that the control variable Ln total assets has a significant negative relationship with beta which is as expected. Whereas against the initial expectation, the PB-ratio is found to have a slight positive relationship with the dependent variable.

All other independent variables, including the interest variables ESG Score, are not proven to have a significant impact on beta. Besides, although not significant with a p-value of 0.4911, the parameter estimate for the ESG Score hints at a negative relationship between the interest variable and beta. Furthermore, the findings from Model 1 are supported by the congruent results from the three robustness tests. Nevertheless, the fact that only two out of five independent variables are found to be significant also reflects in the moderate explanatory power of the model with an R² of 0.0526.

5.4 Results for Model 2 investigating the ESG score's impact on the cost of equity

The regression results for Model 2 including those of the subsequent robustness tests are displayed in Table 8 below.

Table 8: Fixed effect regression result for Model 2 including robustness tests. ***, **, and * indicate statistical significance at a p-value of less than 1%, 5%, and 10% respectively.

<i>Cost of equity (CoE) as the dependent variables</i>					
	<i>Expected direction</i>	Model 2	Without 2020	Excl. ESG Score	Dummy ESG Score
ESG Score	(-)	-0.1347***	-0.1831***	n.a.	-2.1061***
Ln total assets	(-)	-1.3744***	-1.4236***	-2.1650***	-1.8240***
Leverage	(+)	-3.467e-05	-1.314e-05	-4.291e-05	-4.634e-05
ROA	(-)	-0.0723***	-0.0443	-0.0761***	-0.0619**
PB-ratio	(-)	-0.0324	-0.0702***	-0.0475*	-0.0419*
No. of obs.		1625	1247	1625	1625
R ²		0.1693	0.2548	0.0837	0.1213
F-statistic		51.384***	60.389***	28.817***	34.814***

All models display statistical significance at the 1% level. Furthermore, the explanatory power of the main model, Model 2, sits at 16.93% meaning 16.93% of the variation in the cost of equity is explained by the chosen independent variables. Thereby, ESG Score as the central variable in this regression analysis indicates to have a significant negative impact on the cost of equity which is supported by the result of each robustness test. Moreover, its significance is underlined by comparing the values of R² of Model 2 and the model of the robustness test excluding the ESG score as the latter displays only half the explanatory power.

Additionally, Ln total assets and ROA are observed to have the expected negative impact at the 1% significance level in Model 2. While the finding for Ln total assets is supported by all three robustness tests, ROA is not significant in the robustness test omitting observations from 2020. Moreover, while Model 2 finds the PB-ratio not to be significant with a p-value of 0.1229, the robustness tests assert the expected significant negative relationship with the cost of equity. Lastly, the parameter estimate for Leverage does not provide a significant indication regarding the relationship between the variable and the cost of equity across the results from Model 2 and the robustness tests.

5.5 Results for Model 3 investigating the ESG score's impact on the cost of debt

Table 9 gathers the results from the regression analyses of Model 3 and the according robustness tests.

Table 9: Fixed effect regression result for Model 3 including robustness tests. ***, **, and * indicate statistical significance at a p-value of less than 1%, 5%, and 10% respectively.

<i>Cost of debt (CoD) as the dependent variables</i>					
	<i>Expected direction</i>	Model 3	Without 2020	Excl. ESG Score	Dummy ESG Score
ESG Score	(-)	-0.0279***	-0.0246***	n.a.	-0.4599***
Ln total assets	(-)	-0.2674***	-0.2478***	-0.4310***	-0.3565***
Leverage	(+)	-2.546e-05	-2.197e-05	-2.716e-05	-2.791e-05
ROA	(-)	0.0002	-0.0182**	-0.0006	0.0025
PB-ratio	(-)	-0.0170***	-0.0088	-0.0201***	-0.0189***
No. of obs.		1625	1247	1625	1625
R ²		0.1325	0.1342	0.0662	0.0986
F-statistic		38.524***	27.369***	22.357***	27.602***

All four fixed effect regression analyses performed across Model 3 and the robustness tests display statistical significance. Thereby, the expected negative impact of the interest variable ESG Score on a firm's cost of debt is found to be true with negative parameter estimates at the 1% significance level. Additionally, the significance of the ESG Score is again underlined by the higher R² of Model 3 compared to the robustness test model excluding ESG Score.

Considering the other independent variables, one finds Ln total assets to align with the expectation of a significant negative impact on the cost of debt. Leverage on the other hand is not observed to have a significant impact while ROA only in the regression results from the robustness test model omitting observations from 2020 asserts the expected negative relationship with cost of debt at a significance level of 5%. Lastly, the PB-ratio displays the expected negative impact on the dependent variable in Model 3 and the robustness tests except for the robustness test model without observations from 2020.

5.6 Results for Model 4 investigating the ESG score's impact on the WACC

Table 10 below displays the results of the regression analyses of Model 4 and the three robustness tests.

Table 10: Fixed effect regression result for Model 4 including robustness tests. ***, **, and * indicate statistical significance at a p-value of less than 1%, 5%, and 10% respectively.

<i>Weighted average cost of capital (WACC) as the dependent variables</i>					
	<i>Expected direction</i>	Model 4	Without 2020	Excl. ESG Score	Dummy ESG Score
ESG Score	(-)	-0.1115***	-0.1467***	n.a.	-1.7300***
Ln total assets	(-)	-1.3041***	-1.3332***	-1.9588***	-1.6787***
Leverage	(-)	-4.051e-05	-1.623e-05	-4.732e-05	-5.014e-05
ROA	(-)	-0.0231	-0.0178	-0.0263	-0.0146
PB-ratio	(-)	-0.0361**	-0.0706***	-0.0486***	-0.0440**
No. of obs.		1625	1247	1625	1625
R ²		0.1911	0.2606	0.1007	0.1398
F-statistic		59.582***	62.240***	35.323***	40.983***

Hereby, Model 4 and the robustness test models are significant at the 1% level. Of the control variables, Ln total assets and the PB-ratio are found to have the expected negative relationship with WACC as the dependent variable. This finding can be observed across the results for Model 4 as well as the robustness tests. Contrarily, the expectations for the variables Leverage and ROA could not be verified with statistically significant parameter estimates from the fixed effect regression analyses.

Apart from that, the interest variable ESG score is observed to negatively impact a firm's WACC at a significance level of 1% which is supported by the results from each of the robustness tests. Again, comparing R² of the robustness test model excluding the ESG score as an independent variable with R² of Model 4 provides further backing from the significance of the relationship between the ESG Score and a firm's WACC as excluding the score leads to roughly nine percentage points decrease in the explanatory power of the model.

6 Discussion

The research goal of this master's thesis is to empirically investigate the relationship between ESG scores and a firm's cost of capital. Thereby, the reviewed prior research vastly focused on studying the ESG score's impact on only one dimension of the cost of capital. Consequently, the focus of this thesis is to approach the relationship between ESG scores and the cost of capital holistically and compulsorily spanning from the systematic risk to the cost of debt, cost of equity, and eventually the weighted average cost of capital. Furthermore, it is a central assumption of this study that the ESG score and each dimension of the cost of capital have a negative relationship. Against that background, the research framework (Figure 3) concludes higher ESG scores should be associated with lower systematic risk which along the effect chain should lead to lower cost of debt, cost of equity, and average cost of capital. Eventually, the research question "To what extent do ESG scores influence a firm's cost of capital?" is answered by investigating four hypotheses derived from the mentioned research framework (Figure 3) through regression analyses.

6.1 ESG scores do not significantly impact beta

The first hypothesis argues that "*Companies performing well on ESG, represented by higher ESG scores, carry lower systematic risk displayed by lower beta factors.*" and was investigated with an according regression model (Model 1) where the firm's beta factors served as the dependent variable. Asserted by the reviewed literature, it was expected to find a significant negative relationship between the ESG score and the beta factor as previous studies found well-performing companies to display lower systematic volatility as well as lower beta factors (Giese et al., 2019; Gregory et al., 2014). When comparing this expectation with the results of the regression analysis (Table 7), one finds the ESG score to exhibit a negative impact on the beta factor, but that impact does not prove to be significant at a relevant level with a p-value for the ESG score parameter estimate of 0.4911. Followingly, the finding of this research points to the same conclusion as prior research does but the subsequent hypothesis one (H1) does not statistically hold true and thus must be rejected. A potential explanation might lie within the moderate explanatory power of the model with a relatively low R^2 sitting at 5.26%. Ln total assets and PB-ratio are the only independent variables that oppose a significant impact on beta whereby the direction of their impact is in line with the expectations drawn from the literature review.

Discussion

Therefore, they seem to be adequate variables to estimate a firm's systematic risk depicted through the beta factor. Consequently, all other variables included in the model, including the ESG score, do not seem to be meaningful in estimating beta. While a good ESG performance might mitigate certain risks stemming from ESG-related incidents and sources, those risks could be associated with the entity itself and therefore the unsystematic risk which does not drive the beta factor. On the other hand, the beta factor could be an inadequate variable to investigate the risk-mitigating impact of ESG scores as it might not be a good predictor for risk due to the set of other variables that influence the return (Shamsabadi et al., 2012).

6.2 ESG scores have a significant negative relationship with the cost of equity

“Equity capital investors require a lower compensation for their investment in firms with higher ESG scores resulting in lower costs of equity capital.”, is the statement presented in hypothesis two (H2). Accordingly, the cost of equity capital is the chosen dependent variable for the regression model supposed to investigate H2. Thereby, the results from Table 8 suggest that the hypothesis remains true at a significance level of 1%. The parameter estimate for the ESG score displays a value of -0.1347 which indicates a marginal decrease in the cost of equity for the firms if the ESG score increases by one unit. Consequently, the results assert that firms performing well on ESG-related matters are rewarded with a lower expected return on raised equity capital. That finding is supported by the performed robustness tests which all indicate a negative relationship between the ESG score and the cost of equity at the 1% significance level. Thereby, this result is in line with previous research and provides further backing for the observed reduction in the cost of equity as a consequence of a good ESG performance (Dhaliwal et al., 2011; Ng & Rezaee, 2015). Nevertheless, due to the lacking evidence for high ESG scores' mitigating impact on a firms beta factor in this study, the negative relationship between ESG scores and the cost of equity cannot be attributed to a subsequent reduction of the beta as asserted by Sharfman & Fernando (2008). Alternatively, it can be assumed that equity investors account for the risk-mitigating impact of a good ESG performance in a way that was not captured by the design of this study as following the finance literature's definition of the risk-return tradeoff, a lower expected return of an investment is only accepted by the investor if the accommodating risk is adequately lower too.

6.3 ESG scores have a significant negative relationship with the cost of debt

Besides, the empirical results of this master's thesis support the claim stated in hypothesis three (H3) that "*Debt capital providers demand lower compensation for their investment in corporate bonds and loan advancements resulting in a lower cost of debt for firms with higher ESG scores*". The belonging regression analysis with the cost of debt as the dependent variable yields a parameter coefficient of -0.0279 which remains true at the 1% significance level. Consequently, the conclusion of a negative relationship between the ESG score and the cost of debt can be drawn as this investigation of panel data composed of observations from firms listed in the S&P 500 over the period from 2017 to 2021 provides relevant evidence. Furthermore, the finding is in line with previous research indicating a negative impact of ESG scores on the cost of debt capital meaning a better ESG performance and subsequently higher ESG scores lead to reduced cost of debt (Apergis et al., 2022; Raimo et al., 2021). Again, this study was not able to provide empirical evidence for the risk-mitigating impact of ESG scores. Nonetheless, debt capital providers seem to reward high ESG scores with lower costs of debt capital which must trace back to lower perceived risk levels among firms with high ESG scores. Thereby, the work of Gerwanski (2020) might provide an explanation as it finds that increased disclosure activities, which is a common driver of high ESG scores, lead to lower costs of debt for firms. This is due to the reduction in the information asymmetry between the firm and the debt capital provider which allows the latter to better assess the risk associated with the firm. Additionally, firms with high ESG scores are found to have higher risk management and compliance standards which lowers the probability of such firms running into ESG-related issues that negatively impact their financial performance and thus oppose a potential threat to their creditworthiness (Sharfman & Fernando, 2008). Concludingly, the empirical finding of a significant negative relationship between ESG scores and a firm's cost of debt capital could be explained by a reduction of the information asymmetry between firm and investor and due to the perceived bankruptcy risk mitigating character of ESG scores.

6.4 ESG scores have a significant negative relationship with the WACC

As the weighted average cost of capital is composed of the cost of equity and the cost of debt weighted according to a firm's capital structure, a decrease in both should lead to a decrease in the weighted average cost of capital too. This has been the central claim of

Discussion

hypothesis four (H4) regardless of and prior to the previously discussed empirical findings. “*As companies with higher ESG scores face lower costs of equity and costs of debt, their weighted average costs of capital are lower*”, is what H4 reads and has been investigated with a regression model holding the weighted average cost of capital as the dependent variable. Congruent with the expected result, the parameter coefficient for the interest variable asserts a significant negative relationship between ESG scores and the weighted average cost of capital with a coefficient of -0.1115 and a p-value of 0.000. This means, that firms with high ESG scores not only benefit from lower costs of equity and costs of debt capital but that their weighted average costs of capital are lower too. Similar to this study’s empirical findings regarding the cost of equity and the cost of debt, the findings for the relationship between ESG scores and the weighted average cost of capital are in line with prior research (Johnson, 2020; Piechocka-Kaluzna et al., 2021; Sharfman & Fernando, 2008; Suto & Takehara, 2017). Nevertheless, and again similar to the findings for the relationship between ESG scores and the cost of equity as well as the cost of debt, this study fails to provide evidence to directly relate the negative relationship to the significant negative impact of ESG scores on a firm’s beta with the rejection of H1. Although, the arguments and explanations reasoning the significant and expected findings for the relationship between ESG scores and the firm’s cost of equity and cost of debt remain true for the observed relationship between ESG scores and the weighted average cost of capital.

6.5 ESG scores remain significant when sqrt. transforming Leverage

Beyond the immediate empirical findings of the four regression analyses central to this study, further result observations stand out and shall be addressed. Firstly, although the data for the leverage ratios of the firms in the panel dataset have been winsorized, they exhibit a right-skewed distribution as indicated by a mean of 180.194272 which is larger than the median of 80.654480. Incorporating skewed data for one of the control variables in the regression analysis might tamper the parameter estimates and the results for the leverage ratio’s coefficients across the analyses of all four regression models including the robustness tests deliver insignificant and unexpected outcomes. Therefore, the regression analyses have been conducted again with the data for Leverage as a control variable transformed by taking the square root to reduce the skewness in the data. While initially, the coefficient results for Leverage were negative and insignificant across all

Discussion

four regression models which is contradicting the expected direction of the relationships with beta, cost of equity, cost of debt, and the weighted average cost of capital, the coefficient for the relationship with the cost of debt turned positive and together with the coefficient for the WACC aligned with the initial expectation after the transformation (Appendix A). Nonetheless, all coefficient results remain insignificant, and no conclusions can be drawn. Yet, the parameter estimates of the ESG score remain significant and still display the expected negative relationship with the cost of equity, cost of debt, and the weighted average cost of capital in the model with transformed data for the control variable Leverage.

6.6 ESG scores remain significant when omitting the large volatility in 2020

Moreover, it shall be addressed that the explanatory power of the robustness test model excluding observations from the year 2020 is the highest across the four regression models (Appendix B). As elaborated in the robustness test design, led the emergence of the Covid-19 pandemic in 2020 to extraordinary volatility in the S&P 500. Consequently, excluding the observations from that year should allow one to draw conclusions that are not subject to the influence of a black swan event and seemingly provide results that better describe the dependent variables. Thereby, the robustness test models excluding observations from 2020 deliver backing for the initial findings of a significant negative relationship between the ESG score and beta, the cost of equity, the cost of debt, and the weighted average cost of capital from the four main models.

7 Conclusion

Prior research vastly focused on investigating the impact of ESG scores on the cost of debt, cost of equity, and the weighted average cost of capital individually. Consequently, this research intends to enlarge and support the findings of prior research with a holistic empirical investigation that explores the ESG score's impact on all dimensions of a firm's capital costs with regression analyses based on a large panel dataset.

Thereby, this thesis makes a set of contributions to the existing literature with the results for the investigated hypotheses. The assumed risk-mitigating impact of ESG scores as the trigger for an effect chain that leads to a significant negative impact of ESG scores on the cost of capital could not be fed with evidence from the regression analyses of Model 1 investigating the impact of ESG scores on the beta factor. Nonetheless, the results of this study provide further backing for the negative relationship between ESG scores and the cost of debt, the cost of equity, and the weighted average cost of capital that has been observed in the existing literature.

Moreover, considering these results from a company perspective, they imply that good ESG practice and the disclosure of such are rewarded with lower costs for the firm to raise third-party equity as well as debt capital. While good ESG practices of firms are desirable per se and already promoted respectively enforced with a set of regulations and directives, the mentioned implication introduces an economic argument to the managerial considerations about enhancing the ESG activities of a firm. Besides, the finding of a significant negative relationship between ESG scores and a firm's cost of capital supports the effectiveness of policymakers' stringent introduction of regulations and directives on ESG reporting and disclosures. That is because, against that background, firms need to disclose their ESG performance and thus are forced to face the tradeoff between their ESG performance, captured by ESG scores, and their cost of capital. Additionally, the findings of the present research provide valuable insights for finance researchers and professionals working in the field of firm valuations as capital costs are an important driver in a set of valuation methods.

In addition to the limiting factor that no evidence for a significant negative relationship between the ESG score and beta could be provided in this study, respectively that the beta

Conclusion

factor itself might not be an adequate measure of risk to investigate whether firms with higher ESG scores exhibit lower risk levels, the ESG score itself represents a limitation to this study. As discussed in 2.1.2, Eccles & Strohle (2018) argue that there is a variety of ESG score providers with different focus areas and the intention to deliver a proprietary and unique value proposition with their ESG scores which leads to opaqueness and trust issues in the market. This is also reflected in the moderate trust that users i.e., investors and corporates have in the accuracy of the ESG scores (Brock et al., 2023). Nevertheless, the ESG score used in this research is provided by Refinitiv which ranks among the score providers with relatively good scores for the average quality and usefulness of the scores (see Figure 2). Moreover, Refinitiv makes the calculation methods of their ESG scores publicly available to a remarkable extent which decreases the opaqueness of their score composition. Eventually, using a different source of ESG scores might lead to different outcomes but that does not tamper the validity of the results presented in this study as the Refinitiv ESG score is among the best available and vastly adopted scores in the finance industry. Nevertheless, the empirical findings of this study are limited to the panel data used which is data obtained from US-based firms listed in the S&P 500 over the time period from 2017 to 2021, and regardless of the industries they are operating in as such an investigation is out of the scope of this research. Extending the time period, performing a sector-specific investigation of the research question, or contemplating a different stock index might lead to differing results.

Lastly, residual confounding opposes a potential limitation to the findings of this study. The research design is based on four regression models with the beta, the cost of equity, the cost of debt, and the weighted average cost of capital as the dependent variable respectively. Furthermore, the ESG score as the interest variable and the control variables Ln total assets, Leverage, ROA, and PB-ratio were incorporated in each of the regression models. Thereby, the use of the same independent variables for the investigation of the different dependent variables might neglect more specific other variables which potentially could influence the results. The same applies when taking a holistic view as there is the possibility of other variables that were not considered or measured but could have influenced the results.

The findings of this study investigating the ESG score's impact on a firm's cost of capital depict a starting point for further research. First, it might be worthwhile to reproduce the

Conclusion

empirical research with an adjusted regression model 1 investigating the ESG score's relationship with the beta factor. Prior research finds ESG scores to have a negative relationship with beta (Giese et al., 2019; Gregory et al., 2014). The ESG Score coefficient results of this study appear to be negative too but lack statistical significance and the explanatory power of the subsequent regression model is rather low. Therefore, a repeated investigation with a regression model that incorporates other control variables which better explain the variation in beta as the dependent variable might yield significant results. Another approach might be to determine another dependent variable that serves as a more adequate measure of company risk to investigate its relationship with the ESG score. By doing so, further research could be able to arrive at significant results for the ESG score's impact on a firm's riskiness. This would allow for a conclusion regarding the effect chain spanning from the risk-mitigating impact of ESG scores to lower levels of capital costs across the dimensions of equity capital, debt capital, and their weighted average based on significant empirical findings.

Circling back to the mentioned limitations of this study regarding the panel data constructed of observations from US-based firms listed in the S&P 500 over the period from 2017 to 2021, this provides additional starting points for further empirical investigation. Firstly, it could be interesting to investigate the impact that the sectors the firms operate in have on the results which intentionally was neglected in this study's design. Secondly, extending the time period might deliver insights into whether the ESG score's significant negative impact on the cost of capital remains true going further back in time when ESG matters were not as important as they have become over the past few years. Third, the underlying data of this study is limited to US-based firms listed in the S&P 500. Consequently, replicating this study's research approach with panel data drawn from either companies headquartered outside the US or US firms listed in another index could be an intriguing operation and opportunity to compare the results with the findings of this research.

Bibliography

- Apergis, N., Poufinas, T., & Antonopoulos, A. (2022). ESG scores and cost of debt. *Energy Economics*, 112, 106186. <https://doi.org/10.1016/j.eneco.2022.106186>
- Atan, R., Alam, Md. M., Said, J., & Zamri, M. (2018). The impacts of environmental, social, and governance factors on firm performance. *Management of Environmental Quality: An International Journal*, 29(2), 182–194. <https://doi.org/10.1108/MEQ-03-2017-0033>
- Aydoğmuş, M., Gülay, G., & Ergun, K. (2022). Impact of ESG performance on firm value and profitability. *Borsa Istanbul Review*, 22, S119–S127. <https://doi.org/10.1016/j.bir.2022.11.006>
- Baker, M., Hoeyer, M. F., & Wurgler, J. (2020). Leverage and the Beta Anomaly. *Journal of Financial and Quantitative Analysis*, 55(5), 1491–1514. <https://doi.org/10.1017/S0022109019000322>
- Barclay, M. J., Marx, L. M., & Smith, C. W. (2003). The joint determination of leverage and maturity. *Journal of Corporate Finance*, 9(2), 149–167. [https://doi.org/10.1016/S0929-1199\(02\)00003-2](https://doi.org/10.1016/S0929-1199(02)00003-2)
- Bauer, R., & Hann, D. (2010). Corporate Environmental Management and Credit Risk. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.1660470>
- Bellavite Pellegrini, C., Caruso, R., & Mehmeti, N. (2019). The impact of ESG scores on cost of equity and firm's profitability. *New Challenges in Corporate Governance: Theory and Practice*, 38–40. https://doi.org/10.22495/ncpr_9
- Berk, J., & Demarzo, P. (2019). *Corporate finance, global edition* (Fifth). Pearson Education, Limited.
- Bodie, Z., Kane, A., & Marcus, A. J. (2008). *Investments* (7th ed.). McGraw-Hill.
- Bolton, P., & Kacperczyk, M. T. (2019). Do Investors Care about Carbon Risk? *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.3398441>
- Brock, E. K., Nelson, J., & Brackley, A. (2023). *Rate the Raters 2023*. CDC Museum COVID-19 Timeline. (n.d.).
- Chava, S. (2010). *Do Environmental Concerns Affect the Cost of Bank Loans?*
- Chava, S. (2011). Environmental Externalities and Cost of Capital. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.1677653>

Bibliography

- Cheng, B., Ioannou, I., & Serafeim, G. (2014). Corporate social responsibility and access to finance. *Strategic Management Journal*, 35(1), 1–23. <https://doi.org/10.1002/smj.2131>
- Clayman, M. R., Fridson, M. S., & Troughton, G. H. (2012). *Corporate finance: A practical approach* (2nd ed.). John Wiley & Sons, Incorporated.
- Clément, A., Robinot, É., & Trespeuch, L. (2023). The use of ESG scores in academic literature: a systematic literature review. *Journal of Enterprising Communities: People and Places in the Global Economy*. <https://doi.org/10.1108/JEC-10-2022-0147>
- Cornell, B. (2021). ESG preferences, risk and return. *European Financial Management*, 27(1), 12–19. <https://doi.org/10.1111/eufm.12295>
- Curto, J. D., & Serrasqueiro, P. (2022). The impact of COVID-19 on S&P500 sector indices and FATANG stocks volatility: An expanded APARCH model. *Finance Research Letters*, 46, 102247. <https://doi.org/10.1016/j.frl.2021.102247>
- Date, S. (n.d.). *The Pooled OLS Regression Model For Panel Data Sets*. Retrieved June 7, 2023, from <https://timeseriesreasoning.com/contents/pooled-ols-regression-models-for-panel-data-sets/>
- Davis, J. L. (1994). The Cross-Section of Realized Stock Returns: The Pre-COMPUSTAT Evidence. *The Journal of Finance*, 49(5), 1579–1593. <https://doi.org/10.1111/j.1540-6261.1994.tb04773.x>
- Dhaliwal, D. S., Li, O. Z., Tsang, A., & Yang, Y. G. (2011). Voluntary Nonfinancial Disclosure and the Cost of Equity Capital: The Initiation of Corporate Social Responsibility Reporting. *The Accounting Review*, 86(1), 59–100. <https://doi.org/10.2308/accr.00000005>
- Duque-Grisales, E., & Aguilera-Caracuel, J. (2021). Environmental, Social and Governance (ESG) Scores and Financial Performance of Multilatinas: Moderating Effects of Geographic International Diversification and Financial Slack. *Journal of Business Ethics*, 168(2), 315–334. <https://doi.org/10.1007/s10551-019-04177-w>
- Eccles, R. G., & Strohle, J. (2018). Exploring Social Origins in the Construction of ESG Measures. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.3212685>
- El Ghouli, S., Guedhami, O., Kwok, C. C. Y., & Mishra, D. R. (2011). Does corporate social responsibility affect the cost of capital? *Journal of Banking & Finance*, 35(9), 2388–2406. <https://doi.org/10.1016/j.jbankfin.2011.02.007>
- ESMA. (2021). *ESMA Report on Trends, Risks and Vulnerabilities No 1, 2021* .

Bibliography

- Fletcher, J. (1997). An examination of the cross-sectional relationship of beta and return: UK evidence. *Journal of Economics and Business*, 49(3), 211–221. [https://doi.org/10.1016/S0148-6195\(97\)00006-4](https://doi.org/10.1016/S0148-6195(97)00006-4)
- Fletcher, J. (2000). On the conditional relationship between beta and return in international stock returns. *International Review of Financial Analysis*, 9(3), 235–245. [https://doi.org/10.1016/S1057-5219\(00\)00030-2](https://doi.org/10.1016/S1057-5219(00)00030-2)
- Friede, G., Busch, T., & Bassen, A. (2015). ESG and financial performance: aggregated evidence from more than 2000 empirical studies. *Journal of Sustainable Finance & Investment*, 5(4), 210–233. <https://doi.org/10.1080/20430795.2015.1118917>
- Gebhardt, W. R., Lee, C. M. C., & Swaminathan, B. (2001). Toward an Implied Cost of Capital. *Journal of Accounting Research*, 39(1), 135–176. <https://doi.org/10.1111/1475-679X.00007>
- Gerwanski, J. (2020). Does it pay off? Integrated reporting and cost of debt: European evidence. *Corporate Social Responsibility and Environmental Management*, 27(5), 2299–2319. <https://doi.org/10.1002/csr.1965>
- Giannopoulos, G., Kihle Fagernes, R. V., Elmarzouky, M., & Afzal Hossain, K. A. B. M. (2022). The ESG Disclosure and the Financial Performance of Norwegian Listed Firms. *Journal of Risk and Financial Management*, 15(6), 237. <https://doi.org/10.3390/jrfm15060237>
- Giese, G., Lee, L.-E., Melas, D., Nagy, Z., & Nishikawa, L. (2019). Foundations of ESG Investing: How ESG Affects Equity Valuation, Risk, and Performance. *The Journal of Portfolio Management*, 45(5), 69–83. <https://doi.org/10.3905/jpm.2019.45.5.069>
- Godfrey, P. C., Merrill, C. B., & Hansen, J. M. (2009). The relationship between corporate social responsibility and shareholder value: an empirical test of the risk management hypothesis. *Strategic Management Journal*, 30(4), 425–445. <https://doi.org/10.1002/smj.750>
- Gong, G., Xu, S., & Gong, X. (2018). On the Value of Corporate Social Responsibility Disclosure: An Empirical Investigation of Corporate Bond Issues in China. *Journal of Business Ethics*, 150(1), 227–258. <https://doi.org/10.1007/s10551-016-3193-8>
- Goss, A., & Roberts, G. S. (2011). The impact of corporate social responsibility on the cost of bank loans. *Journal of Banking & Finance*, 35(7), 1794–1810. <https://doi.org/10.1016/j.jbankfin.2010.12.002>

Bibliography

- Graham, J., Li, S., & Qiu, J. (2008). Corporate misreporting and bank loan contracting. *Journal of Financial Economics*, 89(1), 44–61. <https://doi.org/10.1016/j.jfineco.2007.08.005>
- Greene, W. H. (2003). *Econometric Analysis* (5th ed.). Prentice Hall International.
- Gregory, A., Tharyan, R., & Whittaker, J. (2014). Corporate Social Responsibility and Firm Value: Disaggregating the Effects on Cash Flow, Risk and Growth. *Journal of Business Ethics*, 124(4), 633–657. <https://doi.org/10.1007/s10551-013-1898-5>
- Guidara, A., Khlif, H., & Jarboui, A. (2014). Voluntary and timely disclosure and the cost of debt: South African evidence. *Meditari Accountancy Research*, 22(2), 149–164. <https://doi.org/10.1108/MEDAR-09-2013-0042>
- Hao, S., Jin, Q., & Zhang, G. (2011). Relative Firm Profitability and Stock Return Sensitivity to Industry-Level News. *The Accounting Review*, 86(4), 1321–1347. <https://doi.org/10.2308/accr-10042>
- He, J., & Ng, L. K. (1994). Economic Forces, Fundamental Variables, and Equity Returns. *The Journal of Business*, 67(4), 599. <https://doi.org/10.1086/296648>
- Hoepner, A. G. F., Oikonomou, I., Sautner, Z., Starks, L. T., & Zhou, X. (2016). ESG Shareholder Engagement and Downside Risk. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.2874252>
- Ilhan, E., Sautner, Z., & Vilkov, G. (2021). Carbon Tail Risk. *The Review of Financial Studies*, 34(3), 1540–1571. <https://doi.org/10.1093/rfs/hhaa071>
- Jo, H., & Na, H. (2012). Does CSR Reduce Firm Risk? Evidence from Controversial Industry Sectors. *Journal of Business Ethics*, 110(4), 441–456. <https://doi.org/10.1007/s10551-012-1492-2>
- Johnson, R. (2020). The link between environmental, social and corporate governance disclosure and the cost of capital in South Africa. *Journal of Economic and Financial Sciences*, 13(1). <https://doi.org/10.4102/jef.v13i1.543>
- Khosravi, N., & Wadman, A. (2022). *Impact of ESG Score on Cost of Capital*. University of Gothenburg.
- La Torre, M., Cardi, M., Leo, S., & Schettini Gherardini, J. (2023). *ESG Ratings, Scores, and Opinions: The State of the Art in Literature* (pp. 61–102). https://doi.org/10.1007/978-3-031-22539-0_4
- Lanis, R., & Richardson, G. (2012). Corporate social responsibility and tax aggressiveness: a test of legitimacy theory. *Accounting, Auditing & Accountability Journal*, 26(1), 75–100. <https://doi.org/10.1108/09513571311285621>

Bibliography

- López Prol, J., & Kim, K. (2022). Risk-return performance of optimized ESG equity portfolios in the NYSE. *Finance Research Letters*, 50, 103312. <https://doi.org/10.1016/j.frl.2022.103312>
- Markowitz, H. (1952). Portfolio Selection. *The Journal of Finance*, 7(1), 77. <https://doi.org/10.2307/2975974>
- Miles, D., & Timmermann, A. (1996). Variation in Expected Stock Returns: Evidence on the Pricing of Equities from a Cross-section of UK Companies. *Economica*, 63(251), 369. <https://doi.org/10.2307/2555012>
- Modigliani, F., & Miller, M. H. (1958). The Cost of Capital, Corporation Finance and the Theory of Investment. *The American Economic Review*, 48(3), 261–297. <http://www.jstor.org/stable/1809766>
- Morgan, D. (2023). *U.S. Congress votes to block ESG investing, Biden veto expected*. <https://www.reuters.com/business/us-senate-poised-consider-blocking-biden-esg-investment-rule-2023-03-01/>.
- Ng, A. C., & Rezaee, Z. (2015). Business sustainability performance and cost of equity capital. *Journal of Corporate Finance*, 34, 128–149. <https://doi.org/10.1016/j.jcorpfin.2015.08.003>
- Pastor, L., Stambaugh, R. F., & Taylor, L. A. (2020). Sustainable Investing in Equilibrium. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.3559432>
- Piechocka-Kaluzna, A., Tluczak, A., & Lopatka, P. (2021). The Impact of CSR/ESG Reporting on the Cost of Capital: An Example of US Healthcare Entities. *EUROPEAN RESEARCH STUDIES JOURNAL*, XXIV(Special Issue 3), 679–690. <https://doi.org/10.35808/ersj/2502>
- PricewaterhouseCoopers. (n.d.). *PwC's 2021 Global investor survey*. Retrieved April 23, 2023, from <https://www.pwc.com/gx/en/services/audit-assurance/corporate-reporting/2021-esg-investor-survey.html>
- Pyles, M. K. (2014). *Applied Corporate Finance*. Springer New York. <https://doi.org/10.1007/978-1-4614-9173-6>
- Raimo, N., Caragnano, A., Zito, M., Vitolla, F., & Mariani, M. (2021). Extending the benefits of ESG disclosure: The effect on the cost of debt financing. *Corporate Social Responsibility and Environmental Management*, 28(4), 1412–1421. <https://doi.org/10.1002/csr.2134>
- Refinitiv. (n.d.). *Refinitiv Workspace*.

Bibliography

- Refinitiv. (2022, May). *Environmental, Social, and Governance Scores from Refinitiv*.
https://www.refinitiv.com/content/dam/marketing/en_us/documents/methodology/refinitiv-esg-scores-methodology.pdf
- Reilly, F. K., & Brown, K. C. (2012). *Investment Analysis and Portfolio Management* (10th ed.). South-Western, Cengage Learning.
- Ribando, J. M., & Bonne, G. (2010). *A new quality factor: finding alpha with ASSET4 ESG data*.
<https://www.thomsonreuters.com/content/dam/openweb/documents/pdf/tr-com-financial/report/starmin-quant-research-note-on-asset4-data.pdf>
- Ruefli, T. W., Collins, J. M., & Lacugna, J. R. (1999). Risk measures in strategic management research: auld lang syne? *Strategic Management Journal*, 20(2), 167–194.
[https://doi.org/10.1002/\(SICI\)1097-0266\(199902\)20:2<167::AID-SMJ9>3.0.CO;2-Q](https://doi.org/10.1002/(SICI)1097-0266(199902)20:2<167::AID-SMJ9>3.0.CO;2-Q)
- Sareewiwatthana, P., & Malone, R. P. (1985). Market Behavior and the Capital Asset Pricing Model in the Securities Exchange of Thailand: An Empirical Application. *Journal of Business Finance & Accounting*, 12(3), 439–452.
<https://doi.org/10.1111/j.1468-5957.1985.tb00845.x>
- Shamsabadi, H. A., Dargiri, M. N., & Rasiah, D. (2012). A Review Study of Risk-Return Relationship and Performance Measures Comparing Different Industry Sectors . *Australian Journal of Basic and Applied Sciences*, 6(12), 14–22.
- Sharfman, M. P., & Fernando, C. S. (2008). Environmental risk management and the cost of capital. *Strategic Management Journal*, 29(6), 569–592.
<https://doi.org/10.1002/smj.678>
- Smith, C. W., & Stulz, R. M. (1985). The Determinants of Firms' Hedging Policies. *The Journal of Financial and Quantitative Analysis*, 20(4), 391.
<https://doi.org/10.2307/2330757>
- Suto, M., & Takehara, H. (2017). CSR and cost of capital: evidence from Japan. *Social Responsibility Journal*, 13(4), 798–816. <https://doi.org/10.1108/SRJ-10-2016-0170>
- Zhu, F. (2014). Corporate Governance and the Cost of Capital: An International Study. *International Review of Finance*, 14(3), 393–429. <https://doi.org/10.1111/irfi.12034>

Appendix

A.	Regression coefficients after square root transformation	XVI
B.	Main models R^2 compared with R^2 of robustness tests excluding 2020	XVI
C.	Fixed effect regression summary of Model 1 (Beta).....	XVII
D.	Fixed effect regression summary of Model 2 (CoE)	XVIII
E.	Fixed effect summary table of Model 3 (CoD)	XIX
F.	Fixed effect regression summary of Model 4 (WACC)	XX

Appendix

A. Regression coefficients after square root transformation

Regression coefficient results of Model 1, 2, 3, and 4 after sqrt. transformation of Leverage

	<i>Expected direction</i>	Beta	CoE	CoD	WACC
ESG Score	(-)	-0.0008	-0.1347***	-0.0279***	-0.1116***
Ln total assets	(-)	-0.1211***	-1.3719***	-0.2682***	-1.2990***
Sqrt. Leverage	(+)	-5.143e-05	-0.0015	0.0026	-0.0854
ROA	(-)	0.0017	-0.0722***	0.0011	-0.0234
PB-ratio	(-)	0.0098***	-0.0324	-0.0178***	-0.0359**
No. of obs.		1625	1247	1625	1625
R ²		0.0526	0.1692	0.1320	0.1909
F-statistic		7.5911***	2.1671***	3.2581***	2.1267***

Source: Own table

B. Main models R² compared with R² of robustness tests excluding 2020

	Model 1 (Beta)		Model 2 (CoE)	
	<i>Model 1</i>	<i>Without 2020</i>	<i>Model 2</i>	<i>Without 2020</i>
No. of obs.	1625	1247	1625	1247
R²	0.0526	0.0604	0.1693	0.2548
F-statistic	14.001***	11.348***	51.384***	60.389***

	Model 3 (CoD)		Model 4 (WACC)	
	<i>Model 3</i>	<i>Without 2020</i>	<i>Model 4</i>	<i>Without 2020</i>
No. of obs.	1625	1247	1625	1247
R²	0.1325	0.1342	0.1911	0.2606
F-statistic	38.524***	27.369***	59.582***	62.240***

Source: Own table

Appendix

C. Fixed effect regression summary of Model 1 (Beta)

PanelOLS Estimation Summary						
Dep. Variable:	Beta	R-squared:	0.0526			
Estimator:	PanelOLS	R-squared (Between):	-10.488			
No. Observations:	1625	R-squared (Within):	0.0526			
Date:	Mon, Jun 12 2023	R-squared (Overall):	-9.9269			
Time:	11:15:35	Log-likelihood	-285.44			
Cov. Estimator:	Unadjusted	F-statistic:	14.001			
Entities:	359	P-value	0.0000			
Avg Obs:	4.5265	Distribution:	F(5,1261)			
Min Obs:	1.0000	F-statistic (robust):	14.001			
Max Obs:	84.000	P-value	0.0000			
Time periods:	5	Distribution:	F(5,1261)			
Avg Obs:	325.00					
Min Obs:	114.00					
Max Obs:	380.00					
Parameter Estimates						
	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
ESG Score	-0.0008	0.0011	-0.6888	0.4911	-0.0030	0.0014
Leverage in %	-3.522e-07	9.045e-06	-0.0389	0.9689	-1.81e-05	1.739e-05
ROA in %	0.0017	0.0025	0.6828	0.4949	-0.0032	0.0067
PB-ratio	0.0098	0.0020	4.8406	0.0000	0.0058	0.0137
ln_Total assets	-0.1212	0.0208	-5.8223	0.0000	-0.1620	-0.0804
F-test for Poolability: 7.5933						
P-value: 0.0000						
Distribution: F(358,1261)						
Included effects: Entity						

Source: Own table

Appendix

D. Fixed effect regression summary of Model 2 (CoE)

PanelOLS Estimation Summary			
Dep. Variable:	CoE in %	R-squared:	0.1693
Estimator:	PanelOLS	R-squared (Between):	-48.383
No. Observations:	1625	R-squared (Within):	0.1693
Date:	Mon, Jun 12 2023	R-squared (Overall):	-39.494
Time:	11:41:32	Log-likelihood	-4088.2
Cov. Estimator:	Unadjusted		
		F-statistic:	51.384
Entities:	359	P-value	0.0000
Avg Obs:	4.5265	Distribution:	F(5,1261)
Min Obs:	1.0000		
Max Obs:	84.000	F-statistic (robust):	51.384
		P-value	0.0000
Time periods:	5	Distribution:	F(5,1261)
Avg Obs:	325.00		
Min Obs:	114.00		
Max Obs:	380.00		

Parameter Estimates						
	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
ESG Score	-0.1347	0.0118	-11.397	0.0000	-0.1579	-0.1115
Leverage in %	-3.467e-05	9.391e-05	-0.3692	0.7120	-0.0002	0.0001
ROA in %	-0.0723	0.0262	-2.7618	0.0058	-0.1236	-0.0209
PB-ratio	-0.0324	0.0210	-1.5439	0.1229	-0.0736	0.0088
ln_Total assets	-1.3744	0.2161	-6.3596	0.0000	-1.7983	-0.9504

F-test for Poolability: 2.1695

P-value: 0.0000

Distribution: F(358,1261)

Included effects: Entity

Source: Own table

Appendix

E. Fixed effect summary table of Model 3 (CoD)

PanelOLS Estimation Summary			
Dep. Variable:	CoD in %	R-squared:	0.1325
Estimator:	PanelOLS	R-squared (Between):	-14.980
No. Observations:	1625	R-squared (Within):	0.1325
Date:	Mon, Jun 12 2023	R-squared (Overall):	-14.094
Time:	11:40:27	Log-likelihood	-1769.8
Cov. Estimator:	Unadjusted		
		F-statistic:	38.524
Entities:	359	P-value	0.0000
Avg Obs:	4.5265	Distribution:	F(5,1261)
Min Obs:	1.0000		
Max Obs:	84.000	F-statistic (robust):	38.524
		P-value	0.0000
Time periods:	5	Distribution:	F(5,1261)
Avg Obs:	325.00		
Min Obs:	114.00		
Max Obs:	380.00		

Parameter Estimates						
	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
ESG Score	-0.0279	0.0028	-9.8199	0.0000	-0.0334	-0.0223
Leverage in %	-2.546e-05	2.255e-05	-1.1289	0.2591	-6.969e-05	1.878e-05
ROA in %	0.0002	0.0063	0.0312	0.9751	-0.0121	0.0125
PB-ratio	-0.0170	0.0050	-3.3761	0.0008	-0.0269	-0.0071
ln_Total assets	-0.2674	0.0519	-5.1529	0.0000	-0.3692	-0.1656

F-test for Poolability: 3.3611

P-value: 0.0000

Distribution: F(358,1261)

Included effects: Entity

Source: Own table

Appendix

F. Fixed effect regression summary of Model 4 (WACC)

PanelOLS Estimation Summary			
Dep. Variable:	WACC in %	R-squared:	0.1911
Estimator:	PanelOLS	R-squared (Between):	-53.292
No. Observations:	1625	R-squared (Within):	0.1911
Date:	Mon, Jun 12 2023	R-squared (Overall):	-44.660
Time:	11:42:13	Log-likelihood	-3715.1
Cov. Estimator:	Unadjusted		
		F-statistic:	59.582
Entities:	359	P-value	0.0000
Avg Obs:	4.5265	Distribution:	F(5,1261)
Min Obs:	1.0000		
Max Obs:	84.000	F-statistic (robust):	59.582
		P-value	0.0000
Time periods:	5	Distribution:	F(5,1261)
Avg Obs:	325.00		
Min Obs:	114.00		
Max Obs:	380.00		

Parameter Estimates						
	Parameter	Std. Err.	T-stat	P-value	Lower CI	Upper CI
ESG Score	-0.1115	0.0094	-11.872	0.0000	-0.1300	-0.0931
Leverage in %	-4.051e-05	7.465e-05	-0.5426	0.5875	-0.0002	0.0001
ROA in %	-0.0231	0.0208	-1.1118	0.2664	-0.0640	0.0177
PB-ratio	-0.0361	0.0167	-2.1639	0.0307	-0.0688	-0.0034
ln_Total assets	-1.3041	0.1718	-7.5917	0.0000	-1.6411	-0.9671

F-test for Poolability: 2.1334
P-value: 0.0000
Distribution: F(358,1261)

Included effects: Entity

Source: Own table